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DEVELOPMENT OF LATENT FINGERPRINTS ON NON-POROUS SURFACES USING WALNUT SHELL FLY ASH

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Abstract: Criminal investigations in the field of forensic science continue to be built around the unmistakable identification of individuals through the study of latent fingerprints. This study has traditionally been restricted to porous surfaces because such materials' natural properties make it easier to see and analyze fingerprint residue. But non-porous surfaces like glass, metal, and plastic have long baffled forensic specialists and investigators, making the production of latent prints dependent on cutting-edge and reliable techniques. The goal of developing latent prints on non-porous surfaces has received fresh life in recent years thanks to the inclusion of novel methods and materials in the forensic toolbox. Among these innovative methods, the use of walnut shell fly ash, a byproduct of the combustion of walnut shells, has drawn substantial attention for it. It offers the possibility of a long-lasting, affordable, and economical technique for latent fingerprint creation on non-porous surfaces.

Index Terms - Latent Fingerprints, Non-porous surface, Development, Walnut shell, Fly ash

I. Introduction

The development of finger prints has been started from the intrauterine stage of fourth month, grows according to the age and remain constant till death [1]. The formation of a finger print on the fingers is helps to griping and holds the things that are in your hand. According to Locard's exchange principle, which states that "Every contact leaves traces," the latent fingerprint is the crime scene print that is most frequently found. The enhancement technique must be carried out in order for the latent fingerprint to be visible to the naked eye [2]. A person's fingerprint is a unique imprint of the papillary ridge arrangement on the ends of their fingers and thumb. The papillary ridges in each human finger are unique and does not change with growth or age, fingerprints provide an absolute form of personal identification. Given its singularity, fingerprints are one of the most prized forms of evidence. Latent prints can be found on a variety of surfaces, although they are no longer always easy to view, and their discovery frequently requires the use of fingerprint powders, chemical reagents, or alternate light sources [3]. The identification of criminals using fingerprints was the first important breakthrough in the scientific study of crime [4]. The judiciary and the general public, as is normal, took some time to believe in fingerprints' scientific utility. Fingerprints are valuable as evidence because they are one-of-a-kind, permanent, universal, inimitable, classifiable, and widely available in crime scenes [5]. They also assist investigators in tracking a criminal's history, including previous arrests and convictions, and in making sentencing, probation, parole, and pardoning decisions [6], [7]. Dactyloscopy is the process of using fingerprints as a form of identification. Conventional procedures used by the latent print examine include dusting, iodine fuming, silver nitrate development, and ninhydrin treatment. Newer techniques, such as metal vacuum deposition and autoradiography, are usually not feasible because they require complex instrumentation and considerable technical expertise.

Current study is based on the development of fingerprints on non-porous surfaces using walnut shell ash. Walnut shells are a versatile abrasive media widely used in blasting, tumbling, cleaning, polishing, filtration, cosmetics, as well as non-skid applications and filler applications. Walnut shells are crushed, ground and classified to standard mesh sizes that range from coarse groin fine powders. In this study it is seen that walnut shell ash adheres to residue left by friction ridges of skin. Walnut shells are easily and commonly accessible, nature friendly, harmless to skin and less expensive.

II. Materials and Methodology

For the conduction of present research following materials are used for the development of fingerprint during standardization process: - air tight glass bottles, mortar and pestle, muslin cloth, sieve, muffle furnace, crucible, hot air oven, walnut shells (sample), forceps, spatula, Petri dish, silica gel beads, clear tape, black paper, dust cloth, small bowl, a fine brush with soft bristles, gloves. Walnut shells were finely crushed by using mortar and pestle and sieved through fine cloth for getting fine powder. The method used here in the development of latent prints is powder dusting. Then they are kept in muffle furnace in order to get fly ash.

Table: 1 – Showing the SOP of making of Walnut shell white powder

S No.	Date	Temperature	Quantity	Time	Remark/Condition
1.	14/02/2022	500° C	2 gm	8.30 am to 12.30 pm	Appeared Whitish
2.	16/02/2022	500° C	2 gm	8.40 am to 1.01 pm	Whitish appearance on upper surface
3.	18/02/2022	600° C	2 gm	11.15 am to 1.15 pm	Whitish appearance
4.	20/02/2022	600° C	2 gm	9.44 am to 11.40 am	Appeared whitish
5.	22/2/2022	600° C	2 gm	12.24 pm to 2.49 pm	Whitish appearance
6.	24/02/2022	600° C	2 gm	10.30 am to 11.30 pm	White fly ash appeared

III. Procedure for the development of fingerprint

The methodology employed in this study involves the utilization of a powder dusting method for fingerprint development. The procedure can be outlined as follows: To begin, a small quantity of powder is placed into a small bowl. Subsequently, the surface designated for the experiment is meticulously cleaned using a dust cloth to ensure a clean and smooth working environment. Following the surface preparation, one finger from the hand is chosen, and it is firmly pressed onto the clean and smooth surface to create a fingerprint. A brush is then carefully dipped into walnut shell powder, with only the tips of the bristles being lightly coated with the powder. Excess powder is removed by tapping the brush gently. The coated brush is used to delicately sweep over the area where the fingerprint has been placed, ensuring that excessive pressure is avoided to prevent smudging of the print. Additional powder may be added to the brush as needed, but caution is exercised to avoid over-application. Upon completing the dusting process, any excess powder on the surface is gently blown off, and the developed fingerprint is inspected for clarity and quality. To preserve and document the fingerprint, a piece of transparent tape is used. The tape is carefully pressed onto the surface, covering the developed fingerprint. Subsequently, the tape is peeled off, transferring the fingerprint onto a piece of paper. This method serves as a reliable means for fingerprint analysis in the study.

IV. **Result**

The result obtained from the present study using walnut shells fly ash on various non porous surfaces (glass, mobile screen, plastic water bottle, wooden door) are shown in fig (1 to 8). The results as shown in figures are obtained when powder dusting method have been applied on different substrates using walnut shells fly ash. Different results are shown when development is done on various substrates depending upon the time of development. The latent fingerprints present on majority of the surfaces examined can be successfully developed with Walnut shells fly ash. It has been observed that latent fingerprints were not developed on rubber using Walnut shell fly ash. Most clear and visible prints were developed on almost all non - porous surfaces such as mobile phone screen, black board, plastic bottle caps, steel caps etc.

Figure.1. – Development of fingerprint on Mobile screen

Figure.2. – Development of fingerprint on Blackboard

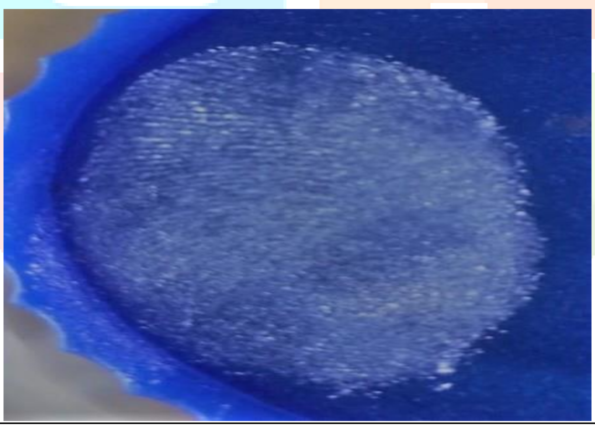

Figure.3. – Development of fingerprint on Plastic bottle cap

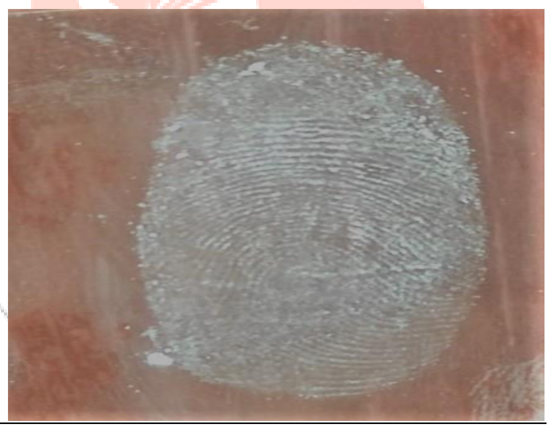

Figure.4. – Development of fingerprint on Wooden door surface

Figure.5. – Development of fingerprint on T.V. remote

Figure.6. – Development of fingerprint on Wi-Fi Dongle

Walnut fly ash is admirable to Mobile phone screen as we can see in Fig.1. Walnut fly ash shows excellent result on black board surface as we can see in Fig.2. In case of plastic bottle cap the result is not that fine and friction ridges are not so clear but it can be easily visualized Fig.3. In case of wooden door surface excellent results are found as we can see in Fig.4. Walnut shell fly ash gives beautiful results on the surface of TV remote Fig.5. and on the surface of Airtel Wi-Fi dongle Fig.6. These preliminary observations indicate that walnut shell fly ash can only be used for visualization of latent fingerprints on various non - porous substrates.

V. Discussion

In a study involving the development of latent fingerprints, various substances were tested for their effectiveness. Swedish soot powder mixture (Swedish black) and Silver special powder, in combination with cyanoacrylate fuming, were employed. The findings indicated that Swedish black powder was the most suitable method for fingerprint development, resulting in a higher percentage of high-quality fingerprints suitable for further examination compared to other techniques [8]. Additionally, walnut shell white fly ash powder yielded good results for non-porous surfaces. A separate study used iron oxide powder in conjunction with atomic force microscopy and scanning electron microscopy to investigate latent prints on smooth, non-porous plastic surfaces. The research aimed to understand the interaction mechanisms between latent fingerprints, the development agent, and the underlying surface [9]. Turmeric, a readily available and non-toxic household item, was used in another study to visualize latent prints. The results demonstrated that turmeric was effective in developing clear prints on various surfaces, except for skin due to the lack of contrast [10]. Walnut shell white powder, which is derived from natural resources like coal, also yielded similar results with easily visible ridges. Another study utilized food coloring agents and festive colors to develop latent fingerprints. The results were clear enough to distinguish patterns and ridges, particularly on light surfaces such as paper, aluminum foil, and CD top surfaces [11]. In a different investigation, black magnetic powder and black powder suspensions were used to enhance and recover latent fingerprints on various food items. These methods appeared to be the most successful in developing prints with a high level of ridge detail over a specific time frame. In a series of studies involving latent fingerprint development, the effectiveness of various substances on different surfaces was examined. Banana, apple, and tomato surfaces demonstrated successful enhancement of latent prints, while potato and egg surfaces yielded less successful results [12]. Notably, walnut shell white powder was found to be effective on non-porous surfaces such as utensils and coolers. Another study employed Silica Gel G powder, a cost-effective and readily available substance used in thin-layer chromatography (TLC) plate preparation. This powder was used to develop latent fingerprints on various substrates, including plastic, glass, mirrors, metallic substrates, aluminum foil, carbon paper, matchboxes, cardboard, glossy-painted wooden surfaces, CDs, and glazed colored magazine paper. Silica Gel G powder yielded clear results on most of these substrates, similar to the performance of walnut shell powder, which is also cost-effective and readily available [13]. Reduced-scale magnetic and non-magnetic powdering materials were explored in a separate study, aiming to develop ridge detail on ivory. The use of cyanoacrylate and fluorescently-labeled cyanoacrylate fuming was found to be less effective compared to reduced-scale powdering in general. This research provided insights into the potential application of smaller scale powdering materials for developing ridge detail on hard, semi-porous biological material [14]. Walnut shell powder, in contrast, is a physical process suitable for specific surfaces. Robin powder blue, a common household product known as 'neel' in India, was utilized in another study. This household product, known for its post-wash whitening properties, was found to be user-friendly, cost-effective, non-toxic, and environmentally friendly. It yielded favorable results on various surfaces commonly encountered in crime scenes [15]. Walnut shell powder shares similar user-friendly and easily available attributes. Two additional studies introduced unconventional methods for latent fingerprint development. One study utilized Fuller's earth (Multani mitti) to successfully develop latent fingerprints left on surfaces such as black cardboard, clear glass, coverslip boxes, steel surfaces, laminated wooden sheets, and plastic surfaces. These studies provided alternative approaches to latent fingerprint development. It was suggested that Fuller's earth (Multani mitti) is a non-toxic reagent and yields more reliable results than chemical reagents for latent print development on various surfaces. However, it has a limitation as it can only develop fingerprints up to 2 days due to its limited adhesiveness [16]. In contrast, walnut shell powder is suitable for developing fingerprints on non-porous surfaces like chargers and remotes but is not applicable on surfaces that have been exposed to water. A study conducted employed black powder, small particle reagent, and cyanoacrylate fuming to recover latent fingerprints. These prints were deposited on metallic, plastic, and glass objects and subjected to submersion in fresh and seawater for different durations. The prints were later evaluated using a fingerprint quality assessment scale [17]. However, walnut shell powder can only develop fingerprints on non-porous surfaces and is not suitable for use on water-exposed surfaces. An experiment conducted using unconventional items such as henna, vermilion, coffee powder, and gram flour on various surfaces for latent fingerprint development. The results produced clear enough prints with visible individual and class characteristics [18]. Similarly, walnut shell white powder can develop fingerprints with clearly visible results. In a study, different fingermark developers were evaluated for the recovery of fingermarks from brass cartridge cases. The latent fingermarks on various surfaces were deposited, aged, and subsequently developed with different reagents [19]. However, walnut shell powder was found to be unsuccessful on metallic surfaces. Introduced cationic dye-diatomite composite powders as novel dusting powders for developing latent fingerprints on various substrates. These composite powders proved to be highly sensitive, selective, and provided good contrast for practical use in forensic science [20]. In contrast, walnut shell powder is composed differently but also yields favorable results. Utilized rock phosphate powder for the development of invisible fingerprints on porous and non-porous surfaces. Fingerprints were successfully developed on ten different surfaces, including paper, plywood, plastic sheets, granite marble, iron, wood, and utensils. The fine dust of Rock Phosphate Powder adheres to the fatty acids present in fingerprint sweat, making the invisible fingerprint pattern clearly visible on various surfaces. Research studies have demonstrated its effectiveness on most surfaces, revealing clear fingerprint patterns and ridges [21]. In contrast, walnut shell powder has been primarily tested on non-porous surfaces and may not yield satisfactory results on porous surfaces. Another study utilized acetone to address fingerprint development issues on thermal papers [22]. The less adhesive nature of walnut shell powder may limit its performance on porous surfaces, such as papers. In a separate study, a fluorescent variant of silica nanoparticle powder, synthesized from rice husk, was employed. These silica nanoparticles were incorporated with natural dyes and investigated for latent fingerprint development on multicolored substrates [23]. While attempts were made to create nanoparticles from walnut shell powder, the large particle size led to the production of fine white powder that can effectively develop fingerprints on various non-porous surfaces. A comparative analysis was conducted on various powders, including titanium dioxide powder, Maranta arundinacea, and Rubus idaeus, to determine their effectiveness in visualizing latent fingerprints. These powders remained stable, and walnut shell powder also proved to be applicable on selected surfaces. This study represents preliminary work in the field of latent print enhancement using a physical method that relies on the mechanical adherence of fingerprint powder particles to the oily components of skin ridge deposits. Walnut shell white fly ash (white powder) has been shown to be a valuable tool for developing latent fingerprints on non-porous substrates. Additionally, it is readily available, cost-effective, and non-toxic, making it suitable for deciphering latent fingerprints.

VI. Conclusion

In conclusion, the findings of this study highlight the promising potential of walnut shells and fly ash as environmentally friendly and cost-effective alternatives to traditional commercial chemical powders for the enhancement of latent fingerprints on non-porous surfaces. The readily available nature of walnut shells, combined with their non-toxic properties, makes them a valuable resource for forensic investigators, especially in situations where resources may be limited. This preliminary observation not only underscores the effectiveness of these natural materials in revealing latent fingerprints but also opens up new avenues for further research and development. One exciting direction for future investigation is the application of walnut shells and fly ash in deciphering aged latent fingerprints, which often present unique challenges in forensic science. These materials could offer a sustainable and practical solution for tackling such cases, potentially leading to breakthroughs in criminal investigations. The study's successful demonstration of the utility of walnut shells and fly ash in the development of latent fingerprints underscores their significance in the field of forensic science. By embracing these eco-friendly alternatives, forensic experts can reduce their reliance on potentially harmful chemical substances and contribute to a more sustainable and responsible approach to fingerprint analysis. Overall, this research paves the way for a greener, more cost-effective, and efficient future in forensic latent fingerprint development.

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