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Enhancing Latent Fingerprint Development with Buckwheat Flour (Kuttu Aata): Exploring a Promising Natural Material for Forensic Investigations

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Abstract: Human beings consist of unique identifying marks in the form of ridges known as fingerprints. Due to its uniqueness and persistence, this fingerprint can be used for many identification purposes in the criminal justice system. These minute traces can be found on various objects from the crime scenes that are not visible to the naked eye, i.e., Latent fingerprints. It is observed that the conventional powders used to develop latent fingerprints are potentially toxic and cause health problems. We have attempted to use household Buckwheat flour (Fagopyrum Esculentum) to decipher latent fingerprints on porous and non-porous surfaces. The powder was applied to the latent fingerprint using a camel hair brush. This flour is easily available in most Indian households and is simple, non-toxic, and inexpensive. This technique can be valuable to investigators in circumstances where they lack conventional powder materials to develop latent fingerprints. The application is easy to perform and can be an alternative method for fingerprint development.

Keywords: non-toxic; latent fingerprint; inexpensive; household product; persistency.

1. Introduction

Developing latent fingerprints is an important aspect of forensic investigation. Conventionally, this is done using various methods such as dusting with black powder, cyanoacrylate fuming, and ninhydrin treatment. However, these methods can be time-consuming, expensive, and require specialized equipment. In recent years, there has been growing interest in alternative methods that are more affordable, accessible, and easy to use. One alternative method is using buckwheat flour (Kuttu Aata) to develop latent fingerprints. The universality, uniqueness, and permanence of fingerprints make them reliable biometric identification evidence in criminal and civil cases worldwide. Applying fingerprints to personal identification is important as physical evidence in crime scene investigation [1,2]. There are

three types of fingerprint evidence found in crime scenes: visible (patent) prints, impression (or plastic) prints, and latent prints, the latter of which last the longest in the crime scene [3]. Most of the fingerprints found at the crime scene are latent and partial, which is not visible to the naked eye, so it is difficult for the investigation officer to identify, develop, and lift them [1]. Regarding criminal matters, there is a need for some means of development or enhancement of their visualization. As a result, the formation of latent print is becoming increasingly important for future action. There are many types of porous and non-porous surfaces, and particular enhancement procedures are chosen for each one based on the surface type, porosity, and latent mark state [4]. Many techniques and methods have been developed to visualize latent fingerprints [1]. Powder dusting is one of the most popular methods for detecting latent fingerprints [5,6]. In the powder dusting method, a fine powder formulation is applied to the fingermark impression with a glass fiber or camel hair brush to identify the latent fingermark. The powder does not attach to the furrows and is free of fingerprint residue. As a result, the powder composition adheres to the ridges but is easily blown away from the furrows. The ridge pattern becomes evident when the powder is colored, and the latent print is said to have formed [7,8]. The contrast between the ridges and the substrate, which allows for minutiae recognition and characterization, is critical for successfully using produced fingerprints for identification [9,10]. Hundreds of powders have been developed over time to adhere to the oil and sweat from sebaceous glands that these latent fingerprints contain, and scientists have developed regular, metallic, and luminescent powders, with the regular powder containing resinous polymer, which aids in adhesion, and colorant, which provides color contrast to the background and aids in fingerprint recording. Metallic powder is a powder made up of interconnected metals that adhere to latent fingerprints. Luminescent powders are made up of natural or synthetic organic derivatives that glow when exposed to laser light, allowing latent fingerprints to be seen [3,9,11,12]. It is seen that these conventional fingerprint powders utilized for developing latent fingerprints are costly, toxic, and pose potential health hazards; that is why there is an immediate need to identify a cheap, non-toxic, commonly available powder as an alternative to expensive, toxic, complicated powders [5,13,14]. Many studies have explored to visualization of fingerprints using different natural powders such as silica gel, turmeric powder, robin blue, fuller's earth, synthetic food, and festival colours [4,15]. The most widely planted species is common buckwheat (*Fagopyrum Esculentum Moench*). Buckwheat is classified as a pseudo-cereal, which means it has both similarities and differences to cereals. It is a dicotyledonic annual plant belonging to the Polygonaceae [16,17]. In the present study, a less expensive, simple and easily accessible household material such as buckwheat flour is used to develop the latent fingerprint on different porous and nonporous surfaces by dusting method. As on the crime scene, if any conventional powder is unavailable, then this easily available household powder can be used as an alternate [9,18]. This study focuses on the assessment of the effectiveness of inexpensive and readily available household powders routinely used in Indian homes for the creation of finger marks.

2. Materials and Methods

This study was performed in Jaipur, India, with an average humidity of 28-30% during April. Camel hair was used to apply the power to the latent fingerprint, and then photographs were taken with scaling using a Nikon B700. The test sebum latent print was acquired from an individual on various surfaces. Before the collection of samples, an individual should clean his hand properly. For collecting the sebum print then, he was encouraged to touch his forehead

and face to collect sebum on his fingertips [3,19,20], which was then applied on various surfaces such as plastic, wood, paper (white and black), metal, glass, ceramic, aluminum foil, etc. Buckwheat flour is applied with a camel hair brush on a surface where the fingerprint was deposited. The powder residues on the ridge's sweat residue are mechanically attached for decipherment [20,21]. The extra powder was removed by gently moving the brush on the print, and then photographs were taken to preserve the fingerprint. The fingerprint developed from this household powder is then preserved for further examination and study [16,22-28]. Then the fingerprints were collected from the different surfaces, i.e., porous and nonporous surfaces. After that, the subject washed his hands properly with soap and dried them. After wiping his fingertip across his forehead, the individual presses his fingerprints on the surfaces with minimal pressure. The Buckwheat flour dusting procedure was used to create latent fingerprints. The powder was strewn/ dusted on a surface, and the print was gently brushed with a camel hair brush to remove any surplus powder that had accumulated on the developing surface. A scale was placed next to the developed print and photographed at a correct angle. On a contrasting surface, the prints are easily seen. With a magnifying glass, fingerprints taken on various surfaces were investigated and compared in terms of print clarity on various surfaces. All the developed fingerprints were graded according to their quality based on the quality grading assessment scale given in Table 1.

Table 1. Finger-mark clarity assessment scale.

Clarity %	Description
0-20	There is no print, and the outline of a print is simply visible.
20-40	There are no identifiable friction ridges.
40-60	The print is nearly blurred and cannot be categorized into one of the three fundamental patterns.
60-80	Friction ridges are only visible in a portion of the print. ''It's possible that prints that have been classified have been smudged. There are visible friction ridges throughout the print. One of the three basic patterns can be recognized (arch, loop, and whorl).
80-100	The print has noticeable ridges along its length. One of the three basic patterns can be recognized. The structure's core and smaller elements (such as bifurcations and the final ridge) are visible.

3. Results and Discussion

The results of latent fingerprint development using buckwheat powder are shown on different porous and nonporous surfaces, including iron, wooden surfaces, glass, plastic, ceramic, steel, cardboard, marble, black paper, and leather. In contrast, the adhesion capability of powder with fatty acids and triglycerides of oil and sweat content present on the fingerprint ridges, the fineness of the powder, and the surface are all important factors in fingerprint creation. Here, we obtained accurate results on all nonporous surfaces with contrasting backgrounds, such as steel and wooden surfaces. Based on Figure 1, we can observe that on porous surfaces, we have found clearly identifiable friction ridges, and the fundamental patterns can be identified because of the presence of a contrasting background, but in the case of rubber, clarity was dull due to less adherence capability yet gives comparable results. Based on Figure 3, it is concluded that nonporous surfaces have distinct ridges found for metal, plastic, steel, and wooden surfaces, but glass and ceramic gave nearly blurred prints due to low adherence and low contrast for buckwheat powder. However, the fingerprints that are developed are of good quality and can be used in criminal investigations for successful fingerprint development. The use of buckwheat powder is a simple, rapid, and effective approach as the powder is easily available, cost-effective, and non-toxic.

3.1. Development of latent fingerprint on the porous surface by buckwheat powder.

We have taken five porous surfaces: varnished wood, cardboard, black paper, leather, and rubber. Varnished wood shows 80-100 clarity % according to Figure 2, in which the prints with identifiable ridges along the length, in the impression minutiae (bifurcation and ridge end) and core is visible in Figure 1 (A), and the basic fundamental patterns can be recognized. Cardboard, black paper, and leather show 60-80% clarity described in Table 1. Prints may have been smeared; only a part of the print has friction ridges visible. The fundamental patterns (loop, arch, and whorl) can be recognized as shown in Figure 1 (B, C, and D). Rubber in non-porous surfaces shows only 40-60% clarity, according to Table 1 in which the prints are nearly blurred and the fundamental patterns are unidentifiable Figure 1 (E).

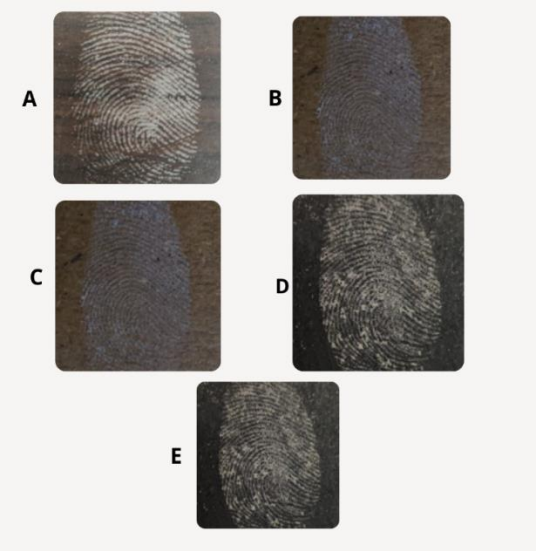

Figure 1. Development of latent fingerprint on porous surfaces using Buckwheat powder. (A: Varnished wood, B: Cardboard, C: Black Paper, D: Leather, E: Rubber).

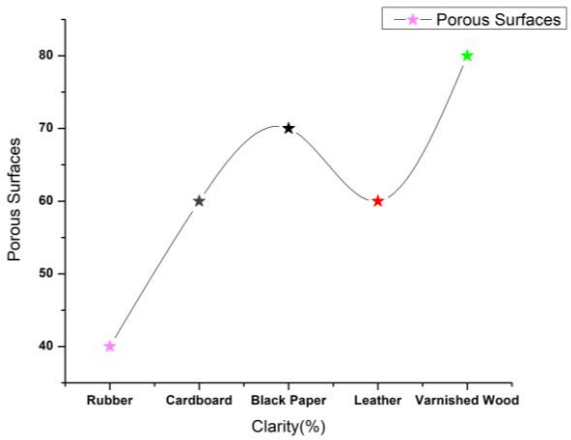

Figure 2. Indicating the relation between fingerprints developed on different surfaces along with their clarity (%) scale.

3.2. Development of latent fingerprint on a nonporous surface by buckwheat powder.

Six surfaces were used to develop latent fingerprints on non-porous surfaces: marble, plastic, steel, ceramic, glass, and iron. Steel shows 80-100% clarity, according to Figure 4, in which the print has recognizable ridges, and fundamental patterns can be recognized. The core structure and minutiae (bifurcation and ridge end) are visible in Figure 3 (H). The surface,

namely marble, plastic, and iron, shows 60-80% clarity assessment shown in Table 1, in which a part of friction ridges prints is visible; the prints that have been categorized may have been smeared. Fundamental patterns can be identified in Figure 3 (F, G, and K). The glass surface shows the lowest clarity percentage, which is 20-40% clarity assessment from Table 1 in which the friction ridges are not identifiable, and the fig shown in Figure 3 (K).

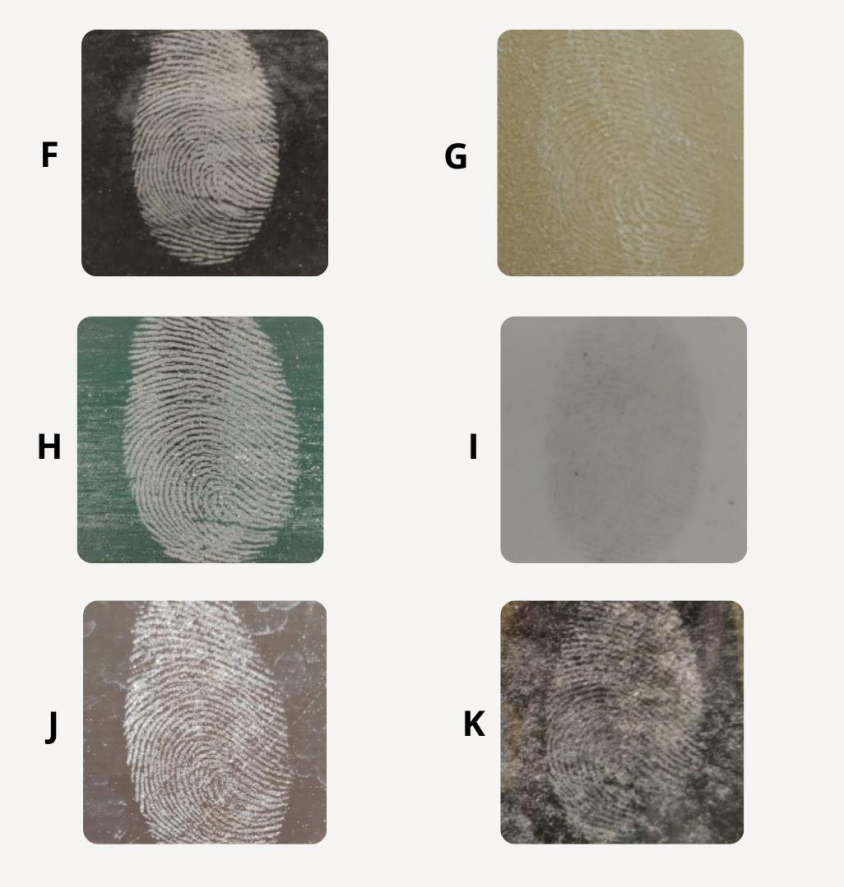

Figure 3. Different latent fingerprints developed on various nonporous surfaces (F: Marble, G: Plastic, H: Steel, I: Ceramic, J: Iron, K: Glass).

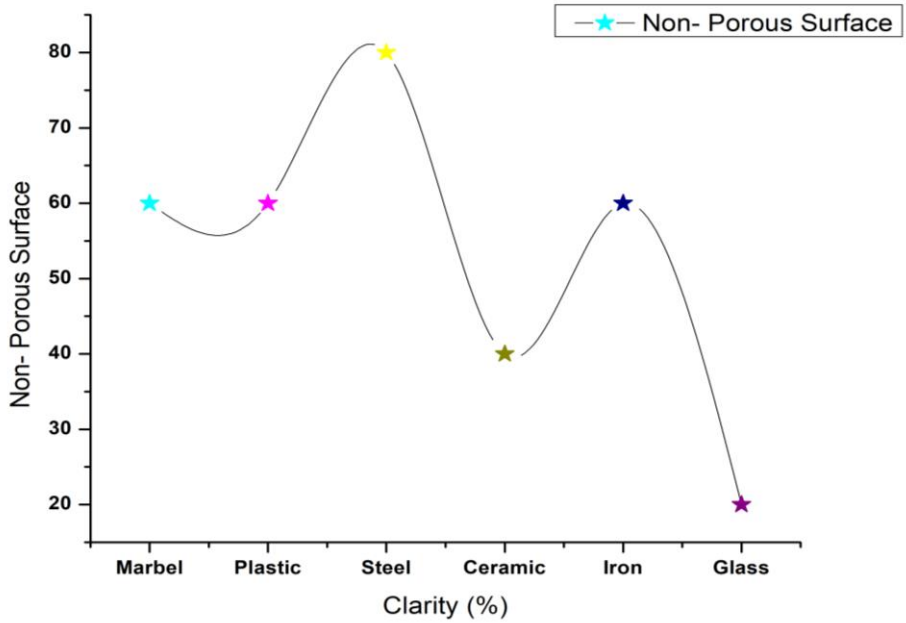

Figure 4. Indicating the relation between fingerprints developed on different surfaces along with their clarity (%) scale.

3.3. Advantage of this study.

Furthermore, buckwheat flour is an environmentally friendly material that does not harm the surface or leave residue behind. It is also easily available in most households, making it a readily accessible material for investigators in urban and rural areas. This method can be particularly useful for developing fingerprints in remote or low-resource settings where conventional methods are not easily available. In addition, buckwheat flour is a valuable alternative for developing latent fingerprints when conventional powders are unsuitable, such as on delicate or sensitive surfaces. It is also a valuable option in situations where preserving the integrity of the evidence is crucial, such as in cases of forensic investigations. Overall, using buckwheat flour for developing latent fingerprints offers a practical and effective solution for investigators that is easy to use, non-toxic, and environmentally friendly.

3.4. Limitations of the study.

It is important to note that using buckwheat flour to develop latent fingerprints may not be suitable for all types of surfaces. For instance, the study revealed that it is not recommended for porous surfaces, as the results were below average according to the fingerprint quality grading scale. Additionally, buckwheat flour may not be effective in areas with high humidity, as it could become sticky and difficult to use. Moreover, the study did not categorize the surfaces further into a semi-porous category, and future research could explore this area in greater detail. Furthermore, other surfaces could be considered for developing latent fingerprints using buckwheat flour, which could result in better quality prints than the 11 surfaces tested in the study. Despite these limitations, buckwheat flour remains a practical and valuable alternative for developing latent fingerprints in various contexts. It is an easily accessible and non-toxic material that can be used without specialized equipment, making it a viable option in low-resource settings. With further research, the effectiveness of this method could be improved and optimized for a wider range of surfaces and environments.

4. Conclusions

Using buckwheat flour as an alternative method for developing latent fingerprints is promising in forensic investigation. This method is simple, safe, and cost-effective, making it a valuable tool for investigators in developed and developing countries. Further research is needed to explore this method's full potential and optimize its performance on different surfaces and under different conditions. The powder dusting method is a sensitive technique for deciphering the latent fingerprint on porous and non-porous surfaces. It’s especially useful when fingerprints need to be seen on any object that any person has left. We have used household material, i.e., buckwheat flour, for this. Using this powder, we have deciphered the fingerprint on both surfaces (porous and non-porous surfaces), such as glass bottles, rubber, iron, black paper, etc. This powder gave clear visualization on contrast surfaces, and an impression was visible. This study concludes that this power is used as an alternative method to the conventional powder for deciphering latent fingerprints. This powder is easily available as well as less effective, eco-friendly, and non-toxic agents, which don’t cause any harmful effects to humans or the environment. Under the right circumstances, they can substitute commercially available chemical powders for fingerprint visualization. Buckwheat powder showed low background interference, high sensitivity, and clear secondary details in latent

fingerprint development at crime scenes compared to other commercially available powders. This method is cost-effective and can be used in sacred areas because this powder is a household product and is a general forum in Indian homes. So, due to the unavailability of conventional powder, this powder is used as a substitute for developing latent fingerprints.

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Conflicts of Interest

The authors declare no conflict of interest.

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