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Exploring the Forensic Potential of Ashwagandha (Withania somnifera) Powder: A Novel Approach for Enhancing Latent Fingerprint Development

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Abstract: In past years, the way of approach in fingerprint development technology has been shifted to eco-friendly and convenient methods as various medicinal and non-conventional household powders like Terminalia powder, Bitter melon, Hingvastak powder custard powder, baking powder, corn flour powder, etc., were developed and used over any other commercial powder as they are cost-effective, easily available. Ashwagandha powder (*Withania somnifera*) is a non-toxic and eco-friendly herbal powder with great medicinal value. Different surfaces were used for the development, like aluminum foil, plywood, rubber, leather, etc. In this research study, we have sprinkled Ashwagandha powder over different porous and non-porous surfaces using an ostrich hair brush. Prints were visible on both surfaces. Although we got a good result (except for leather) with high-contrast fingermarks on all surfaces, the aluminum foil and plywood fingerprints got the maximum clarity score. This study is an eco-friendly approach to developing fingerprints using Ashwagandha powder and an effective technique at a crime scene.

Keywords: herbal powder; fingermarks; Ashwagandha; latent print.

1. Introduction

A fingerprint is one of the most important features of human beings, and it is a unique characteristic of humans. Every individual has different fingerprints. Fingerprints remain the same and unchanged throughout life. The fingerprint is formed from the dermis layer of the skin [1-3]. On the scene of a crime, we find many different physical evidence like glass evidence, fiber evidence, hair, and various types of prints like palm prints, footprints, and fingerprints are one of them [4-6]. Fingerprints are mainly classified into three types- latent fingerprints, patent fingerprints, and plastic fingerprints. Chemical methods are used to develop

latent fingerprints. A fingerprint can be developed by treating the surface with various chemicals like ninhydrin or the iodine fuming method [7,8]. Another method that is the most convenient and easy way to develop latent fingerprints is the powder dusting method [9-11]. Various powders are used to develop latent fingerprints, like titanium dioxide, manganese dioxide, and ferric oxide [12-14]. These all are most hazardous to human health. Lead, mercury, carbon, and titanium-based powder can produce toxicity in humans and cause cancer or metal poisoning. It was found that Cyanoacrylate causes health risks and increases skin disorders to officials. The chemical-based powders are toxic and costly. So, herbal powders are developed and used to develop fingerprints, and they are found to provide high-quality images of fingerprints. Figure 1 provides a timeline showing the use of various herbal powders for fingerprint development. A type of herbal powder, i.e., Ashwagandha powder, is used here to develop fingerprints on various surfaces.

Ashwagandha is the evergreen shrub used for medicinal purposes for medicinal purposes in Ayurveda for the last 3000 years [15,16]. The Ashwagandha plant is mostly cultivated in India and some parts of Africa. The parts of the Ashwagandha plant used for medicinal use are root and orange color seeds. Ashwagandha is also known as Indian Ginseng. The word Ashwagandha comprises two word- “ashwa” which means “horse” and “gandha” which means “smell” [17-19]. The root of these plants smells like a horsey. The scientific name of the Ashwagandha plant is *Withania Somnifera*. Since ancient times, Ashwagandha has been used as an antioxidant, adaptogen, liver tonic, anti-inflammatory agent, astringent, and many more for treating ulcers, bacterial infections, and venom toxins. The classification is shown in table 1.

Table 1. Taxonomical classification of Ashwagandha [15].

Kingdom	Plantae
Division	Angiospermae
Class	Dicotyledons
Order	Tubiflorae
Family	Solanaceae
Genus	*Withania*
Species	*somnifera*

It is a small shrub plant of the family *Solanaceae*. The maximum height of the plant is near about 2 feet. This plant is mostly found in dry regions of India like Rajasthan, Madhya Pradesh, Punjab, Haryana, Uttar Pradesh, Gujarat, and Maharashtra. The cultivation time of Ashwagandha is about 150-180 days. The roots of these plants is fleshy and whitish brown and are used for therapy [20]. This plant consists of different chemicals like ashwagandhine, cuscohygrine, anahygrine, tropine, withaferin A, starch, glucose, reducing sugar, amino acid, aspartic acid, glutamic acid, and more constituents of iron [21]. Ashwagandha has been used for many decades, or we can say that it has been used since ancient times. This plant is used for the treatment of psychological issues like Parkinson’s and Alzheimer's. Much research shows that this plant root is used for treating depression and anxiety. It also helps in treating chronic diseases. The root of this plant help for treating various skin cancer diseases [22,23].

According to a study, Ashwagandha powder can be valuable in developing fingerprints at crime scenes. The powder showcases clear ridge characteristics on both porous and non-porous surfaces, as indicated in Table 2. The study recommends using herbal powders such as Ashwagandha powder for individual identification through clear ridge characteristics instead of toxic, chemically produced powders. This alternative approach is not only cost-effective but also safer for human use. The clear ridge characteristics displayed by Ashwagandha powder on

various porous and non-porous surfaces make it a useful resource for developing fingerprints at crime scenes. Overall, the study highlights the potential benefits of using herbal powders in forensic investigations and specifically emphasizes the advantages of Ashwagandha powder in individual identification.

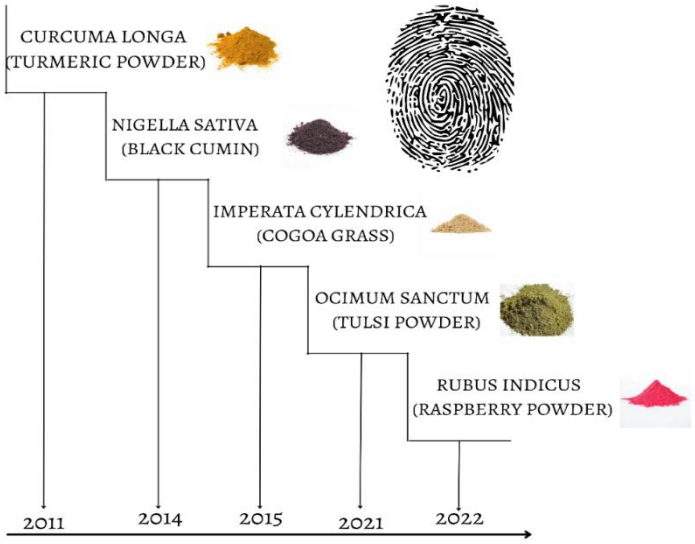

Figure 1. Timeline showing the use of herbal powder for the development of latent fingerprints.

2. Materials and Methods

The following research study was performed in December. This research was performed in Jaipur, Rajasthan. To develop latent fingerprints, the hands of the donor were washed properly and dried. The palm was closed with the thumb inside for sweat formation [24]. After sweat formation, the donor was made to press their thumb on the surface, and Ashwagandha powder was applied to the surface with the help of an ostrich hair brush. The powder was applied, spread on the surface where the fingerprint was present, and extra powder was removed. Due to the adhesive property of the powder, the powder was attached to the fingerprint. The developed fingerprint was photographed for the analysis of fingerprint and identification. Their clarity score on the surface was given by the Fingerprint grading scale system as described in Table 2 grading scale system. The specific characteristics and descriptions may vary depending on the organization or agency using the system. However, the general idea is to use a standardized system to assess the quality and clarity of fingerprints, with higher grades indicating better quality and clearer ridge characteristics. This system can be useful in forensic investigations and criminal cases to help determine the reliability and accuracy of fingerprint evidence.

Table 2. Fingerprint grading scale system [25].

Clarity Score (%)	Description	Characteristics
0-20	Poor	The outline of the developed print is fully smudged or has no evidence of print.
20-40	Fair	Ridges developed cannot lead to the identification
40-60	Good	Part of the developed fingerprint is majorly smudged or not developed properly; although ridge details are present but analysis cannot be performed.
60-80	Very Good	Prints are developed properly, but a minor part of the print is smudged; analysis can be performed.
80-100	Excellent	Clear ridge details appeared, and identification can be done properly.

3. Results and Discussion

The powder-developing method is a physical technique for the development of fingerprints. This physical technique depends upon the adherence capacity of the powder and how the powder attaches or reacts to the sweat composition of the fingerprint. The basic composition of sweat is fatty acids and oil triglycerides; a major part of the sweat is water and other chemicals. Porous and non-porous surfaces have their adhesive property. After applying and developing a latent fingerprint using Ashwagandha powder, the fingerprint developed on porous and non-porous surfaces, as shown in Table 3. The clarity score of fingerprints developed on these surfaces was given based on Table 2.

Table 3. Visualization and Analysis of Fingerprints developed on different surfaces.

S.no.	Images of fingerprints on the surfaces	Surfaces	Clarity score in percentage %	Description
1)		Aluminum foil	80-100%	Clear ridge details appeared, and identification can be done properly.
2)		Plywood	80-100%	Clear ridge details appeared, and identification can be done properly.
3)		Granite	60-80%	Prints are developed properly, but a minor part of the print is smudged; analysis can be performed.

S.no.	Images of fingerprints on the surfaces	Surfaces	Clarity score in percentage %	Description
4)		Steel	60-80%	Prints are developed properly, but a minor part of the print is smudged, so analysis can be performed.
5)		Leather	0-20%	The outline of the developed print is fully smudged or has no evidence of print.
6)		Fibre	60-80%	Prints are developed properly, but a minor part of the print is smudged; analysis can be performed.
7)		Rayon	40-60%	Part of a developed fingerprint is majorly smudged or not developed properly; although ridge details are present analysis cannot be performed.
8)		Rubber	40-60%	Part of a developed fingerprint is majorly smudged or not developed properly; although ridge details are present analysis cannot be performed.

As per Table 3, the best result was on 2 surfaces, i.e., aluminum foil and plywood, with a clarity score of 80-100, which shows that there is proper development of fingerprint and identification can be done. Surfaces like granite, steel, and fiber have a clarity score of 60-80. Rayon and rubber show a clarity index of 40-60, and scores, such as leather, produce lower quality impressions, as the ridges and minutiae are less defined and harder to distinguish).
These surfaces do not show proper fingerprint development, so analysis can't be performed. Leather shows a clarity score of 0-20 because the print on this surface cannot be visible, and identification cannot be performed. A Venn diagram is also provided in Figure 2, which shows the surfaces used for fingerprint development and their clarity score. Figure 3 shows the graphical analysis of prints on these surfaces and their clarity on these surfaces. We can see that the highest peak was obtained for surfaces aluminum and plywood, which had the highest clarity scores, and the lowest peak was obtained for leather, which had the lowest clarity score; hence, analysis cannot be performed on this surface.

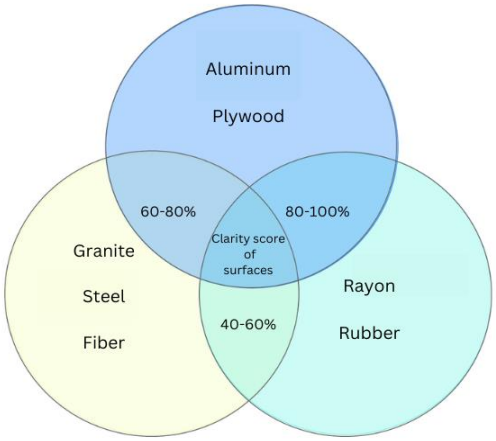

Figure 2. A Venn diagram can be used to illustrate the clarity index of various surfaces. The diagram reveals that granite, steel, and fiber surfaces exhibit a clarity score ranging from 60-80%, indicating moderate clarity. On the other hand, rayon and rubber surfaces exhibit a clarity score ranging from 40-60%, indicating lower clarity levels. Notably, aluminum foil and plywood surfaces exhibit the highest clarity score, ranging from 80-100%, indicating the highest level of clarity. This Venn diagram serves as a useful visual tool for understanding the differences in clarity index across different surfaces.

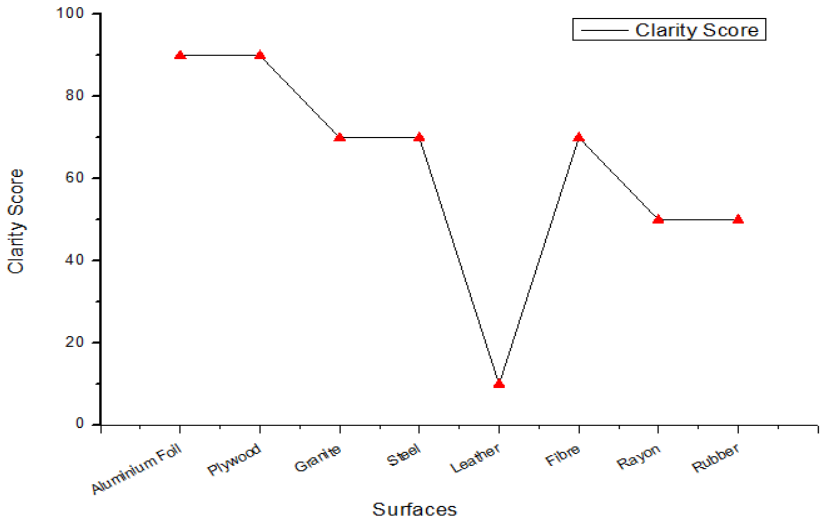

Figure 3. Assessment of fingerprint on surfaces with clarity score (A graph can be used to demonstrate the relationship between the clarity score of a surface and the quality of the resulting fingerprint impression. The graph reveals that surfaces with higher clarity scores, such as aluminum foil and plywood, produce higher quality fingerprint impressions, as measured by the ridges' and minutiae's clarity and detail. In contrast, surfaces with lower clarity.

3.1. Discussion

After conducting experiments on eight different surfaces, namely aluminum foil, plywood, granite, steel, leather, fiber, rayon, and rubber, fingerprints were successfully developed. On most of the surfaces developed, latent fingerprints were developed by Ashwagandha powder. In Table 3 the average surfaces of aluminum foil and plywood have the clarity score for the non-porous surfaces is 90% as compared to porous surfaces. There is no development of latent fingerprints and a minimum clarity score in porous surfaces like leather. Researchers used many household powders and cosmetic powders for the development of latent fingerprints like turmeric powder, cocoa powder, coffee powder, agarbatti ash, and various waste materials like orange peel, lemon peel, and other fruit waste materials for the development of latent fingerprints and their results show that this powder shows the better result on non-porous surfaces. After the development of the fingerprint, it can be run on AFIS Automated Fingerprint Identification System. AFIS is the system where the minute minutia characters are analyzed to identify the fingerprint with the known person [26-29]. AFIS system consists of 4 stages: segmentation, quality assessment, and enhancement and matching, as shown in Figure 4. AFIS system is used in colleges, schools, education institutes, banks, government offices, and other places for attendance and payment transactions.

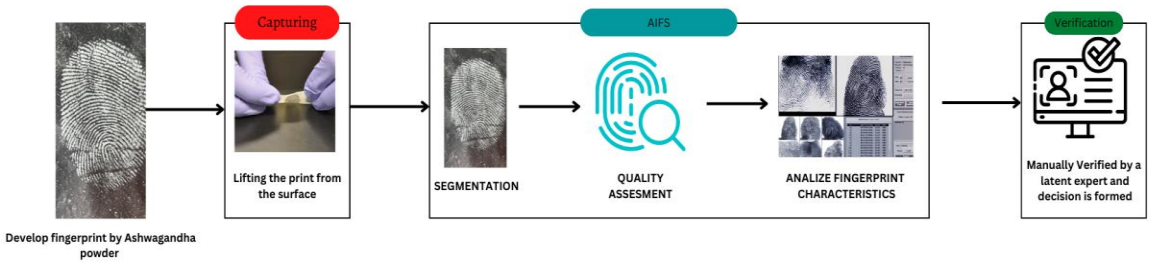

Figure 4. Analysis of fingerprints on the AFIS system for the identification of fingerprints developed by Ashwagandha powder.

3.2. Limitations of the study.

Research is limited to only dry surfaces and gives better results on non-porous surfaces. Further study can be carried out on the Ashwagandha powder to develop fingerprints on porous surfaces. This powder shows results only on contrast or dark surfaces. The powder needs to be sprinkled in the proper quantity due to less adhesiveness towards the surfaces, but the quality of the prints developed is not affected by this.

4. Conclusions

The physical method for developing latent fingerprints is the simplest and most commonly used method. The powder-developing method is the oldest and most convenient method. This study is based on using the herbal Ashwagandha powder to develop latent fingerprints. The naturally occurring plant Ashwagandha root can be used to develop fingerprints by powder dusting. This research study develops latent fingerprints using Ashwagandha powder on non-porous surfaces. However, this powder is not effective on porous and bright surfaces. This research concludes that the Ashwagandha powder can be used to develop latent fingerprints as the alternate source of the other powder, which is expensive and toxic. The Ashwagandha powder has many medicinal values and is cheaper and non-toxic. This

powder doesn't do any harm to the environment. This research can effectively be useful in the forensic science for developing latent fingerprints. As Ashwagandha is used for medicine and therapy, it is safe and non-toxic, so it will be better for the development of fingerprints without causing any harm to officials. Further studies can be conducted on this research of Ashwagandha to develop latent fingerprints where various temperatures, surfaces, and humidity can be treated. That is what result outcomes show after treating various surfaces with different temperatures and humidity.

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Conflicts of Interest

The authors declare no conflict of interest.

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