Journal of Forensic Science & Criminology
Volume 9 | Issue 1
ISSN: 2348-9804

Review Article Open Access

Detection Potential of Recently Discovered Techniques for Recovering Latent Fingerprints: A Review

Puri A*

Department of Biological Sciences, Sunandan Divatia School of Science, NMIMS (Deemed-to-be) University, Bhaktivedanta Swami Marg, Vile Parle (W), Mumbai – 400056, India.

***Corresponding author:** Puri A, 35, 1st floor, Double Storey, N.R.N. New Delhi 110060, India, Tel: 9999905905, E-mail: arzoopuri14@gmail.com

Citation: Puri A (2021) Detection Potential of Recently Discovered Techniques for Recovering Latent Fingerprints: A Review. J Forensic Sci Criminol 9(1): 105

Received Date: February 23, 2021 **Accepted Date:** April 15, 2021 **Published Date:** April 17, 2021

Abstract

Background: Criminals have an aim, to not leave any evidence behind at the scene of crime. Some offenders assume that objects recovered from aquatic environment have no forensic value therefore; they attempt to wipe out the evidences by throwing them (traces like murder weapon) in water. These evidences tend to show destructive properties due to environmental effects. Several studies have stated that factors like; nature of the surface, light exposure, nature of aquatic environment influence the quality and quantity of developed latent finger-prints. This can result in a challenge for forensic experts investigating fingerprints. Therefore, it is important to determine optimal methods to examine latent fingerprints. The present review describes the optimum or the most suitable method for different surfaces.

Results: Methods such as CA Fuming, Robin Blue, Rock Phosphate Powder and, Different soil samples are most effective for materials like plastic, aluminum foil, paper and glass respectively. The results were developed fingerprints with sharp and enhanced visual appearance. The visibility score of these methods is generally in range of 2 -5. None of them produced blurred prints.

Conclusion: The condition of the evidence doesn't matter; they should always be examined for retrieval of prints because fingerprints provide information about details like gender of the offender. Optimal methods can be used for detection but still due to the effect of submersion in water results aren't always good. Therefore, more research needs to be conducted, so that good quality prints as end point are consistently observed.

Keywords: Latent Fingerprints; Surface; Detection Technique; Seawater; Fingerprint Quality

List of abbreviations: UV: Ultraviolet; CA: Cyanoacrylate; SMP: Silver Magnetic Powder; SPR: Small Particle Reagent

Introduction

The word latent in the term "latent fingerprints" means dormant or by chance. So, the prints which are present or found at the location of crime are called latent fingerprints. In other terms, they are fingerprints which are left in a blurred form on the outer surface of materials like glass by oil or some other thick substance like sweat. These prints are extremely important for the crime location investigation. By identifying /recovering these latent prints, they can be matched with fingerprints present in the database. If the latent print found at the crime area is recognized or matched with some print in the database, then it gets easier to catch the culprit. Therefore, fingerprint being a distinctive feature for every individual and one of the most ancient and publicly accepted forensic based evidence used to establish separate identity of culprits needs to be recovered and examined.

Common Method

Latent fingerprints are found and darkened by the use of powder which merges with the background and enhances the fingerprint found on the surface. The selection of powder depends on the PRINCIPLE OF CONTRAST which states that the arrangement of opposite elements to create a visual interest is necessary. For example, a) dark versus light colours like black and yellow / brown versus peach b) raised versus hollow or c) big versus small [1].

Common Mechanism

Now the question comes that how are these latent finger-marks formed. It is a known fact that the surface of finger (all over the ridges) is mostly found wet because of the presence of excreta from the sweat glands present in our body and fat which is constantly given out from the skin. The surface of material comes in contact with the excreta from sebaceous glands. Due to the presence of

excreta and fat, the finger is wet. Therefore, when it touches an object such as glass or lamp, the excreta in the ridges of fingers gets transferred to the object in contact and leaves a mark called a fingerprint [1]. The object of contact can be anything, but these prints are more easily available or visible on smooth surfaces. These prints are of two types found on the crime investigation location; one which can be seen by a naked eye called tangible fingerprint and other which cannot be seen by a naked eye called intangible fingerprint. Usually the culprit's main goal is to not leave any evidence behind. To achieve this, sometimes they dispose of the items used to commit crime in the water assuming those items (having finger-marks) if recovered will be of no use to the investigation. But this is not solely true.

Traditional Methods and their Drawbacks

According to ancient history, General Powder dusting, Small Particle Reagent (SPR), Ninhydrin, Iodine fuming were amongst the most regularly applied detection methods for recovering and developing latent finger-marks. These traditional methodologies have been quite effective for a variety of surfaces. Following are the commonly used classical methods [2].

SPR is a detection technique based on chemical (hydrophobic tail) used to detect prints from non-porous wet surfaces. In this method, tiny black particles get attached to the fatty substance present within a fingerprint remnant. SPR Black is used with detergent and Zinc Carbonate. The chemical reaction results in the formation of a black precipitate. In a study, it was used to recover prints from an aluminium surface and a glass surface. Fingerprint quality for aluminium surface was degraded due to longer duration of submersion and not found satisfactory in terms of contrast. In comparison to aluminium surface, fingerprint recovery from glass surface was still better [3]. Despite having moderate detection ability for some surfaces; there is no specific justification to explain the interaction between fatty substance and tiny particles. Hence, further studies have to be conducted to utilize it [2,4].

Iodide Fuming is a traditional chemical technique based upon the binding interaction between heated forms of iodine crystals and lipid constituents present in a fingerprint residue. Rather than changing the chemical reactants, it simply enhances the emergence of latent finger-marks. Though it is a fast, non-destructive well suited suitable technique for non-porous and porous surfaces, the latent fingerprints have been declared having a transient nature [5]. Due to this limitation, visualized fingerprints are fixed with a chemical fixing reagent. Another study has reported iodine vapour having a toxic as well as corrosive nature. Hence, precautions are required [4,5].

Ninhydrin is another chemical based traditional method in which ninhydrin compound reacts with the amino acids present in the oil obtained fingers. It gives a blue-purple stain pattern and this technique was an early addition for identification of latent fingerprints [6]. According to a study based on ninhydrin method, latent fingerprints which have to be derived from accidentally or purposely wetted surfaces cannot be developed using the ninhydrin compound and to overcome this limitation other methods have to be applied [7].

Drawbacks like low contrast, sensitivity, and selectivity, high toxicity have been shown by such traditional methods [8]. Due to these limitations, scientists have tried to improve these existing methods for better visualization of developed latent fingerprints since they don't have detection potential for all surfaces [2].

Nowadays, it is possible to recover fingerprints from items dumped in water bodies using different physical and chemical methods. In the recent years, new advancement has taken place in the field for fingerprint visualizing techniques [9]. These techniques not only detect the prints, but also identify them. As mentioned before, these fingerprints help in determining the identity of the offender thereby increasing the efficiency of the crime investigation. The quality of the finger impressions might differ, but they are still helpful form of evidence. That is why it is important to assess the evidence for latent finger impressions. Since for the assessment and development of fingerprints, a lot of methods have been developed but not all show satisfactory results therefore the main purpose of paper is to sum up and give a detailed account of the most effective and non-toxic methods available and suitable for different surfaces.

Main Text

Fingerprint quality examination

The latent fingerprints which are usually developed using different techniques are examined using a magnifying glass and then are captured via photographs. There are a lot of factors that affect the quality of the developed finger marks [10-15]. The main factors are as follows:

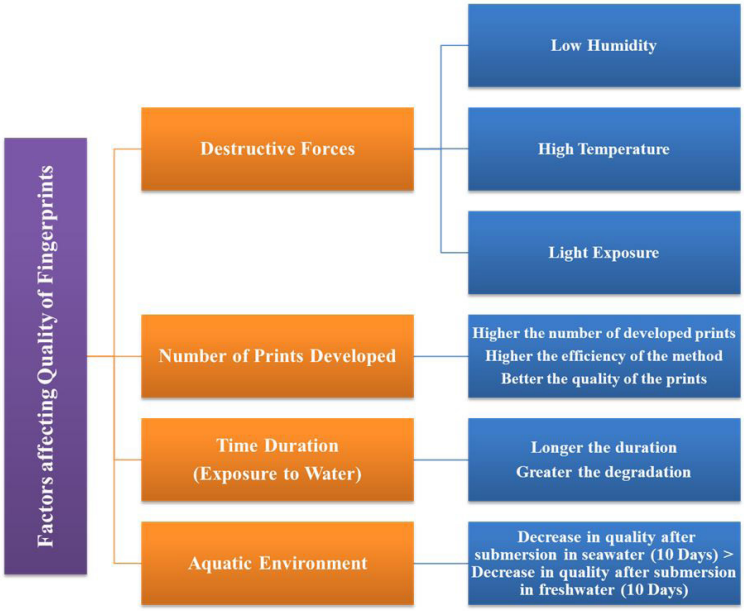


Figure 1: Factors affecting quality of developed latent fingerprints. Information attained from [12,16]

Selection of a method to recover latent fingerprints is depended on the various factors mentioned in the above flowchart. Overall, the chart showcases a direct relationship between Number of Prints and quality of obtained prints. An indirect relationship between Temperature, Light Exposure, Humidity, Environment and quality of latent finger-marks is also seen. It also suggests that based on the aquatic environment, seawater has a more damaging effect on the quality. Hence, to estimate the quality of the finger marks and to determine which methods develop the supreme quality fingerprints the following assessment Table 1 is used.

Score	Quality	Observation
Score 1	No/blur print	Either the finger-marks are invisible or only the outer line is seen clearly.
Score 2	Bad visibility	Frictionless ridges are clearly defined. The prints found do not lie under the normal categories, instead they are smudged.
Score 3	Poor visibility	On a portion of print, friction ridges are found. There is a possibility they are obstructed.
Score 4	Good visibility	Majority portion of prints have well-defined friction ridges. They are categorized as one of the three basic patterns; arch, loop or whorl
Score 5	Very good visibility	Entire surface of prints are covered with well-defined friction ridges.

Table 1: Assessment Table for predicting the quality of developed fingerprints or finger-marks detected using different techniques. The table is based on information gathered from [10,11,14-16]

Based on the quality assessment table, below are the most effective methods (score of 3-5) for development and analysis of fingerprints on various surfaces.

Most Potentious/Effective Methodologies

Latent fingerprints can be developed using a number of physical, optical and chemical methods. Physical methods used to develop latent fingerprints involve physical interaction with deposits of impressions [17]. Chemical methods involve the development of prints by converting any particular constituent of sweat into a coloured derivative. Optical methods use electromagnetic radiation of appropriate wavelengths to analyse and visualize fingerprints. These methods can be used in combination or alone [17]. Due to research in the field of forensic science, it is known that a lot of methods are available or developed for detection and identification of fingerprints, but the choice about which one should be used depends on the nature, texture, environmental factors and colour of the surface on which the latent fingerprint is impinged [17]. There is no single technique which is ideal or appropriate for developing finger-marks on all the surfaces irrespective of the factors like effect of submersion involved. Although a lot of researchers have tried to develop same (high) quality prints on different surfaces using one method but, none have concluded their studies as a positive result to prove that such a development is possible. Mostly one method develops prints only on few surfaces. Therefore, different techniques need to be applied on different surfaces. It is a known fact that traditionally powder dusting was the most common technique used but nowadays it is not always effective. Keeping these statements in mind, the following methods are most suitable for surfaces like glass (Table 2).

Method	Surface/ Type of Material	Reference
Robin Blue	Aluminium, Painted iron, wood, silver	Neeti Kapoor (2015, 2019) [16]
Cyanoacrylate Fuming	Non-porous (Glass, Metal, Plastic)	Somaya Madkour (2017) [13]
Rock Phosphate Powder (non- toxic)	Porous/non-porous (Paper, granite)	Mahipal Singh Sankhla (2018) [18]
Different soil powders (non- toxic)	All surfaces (Glass / Aluminium) except skin and cotton	Dinesh Kamble (2018) [19]

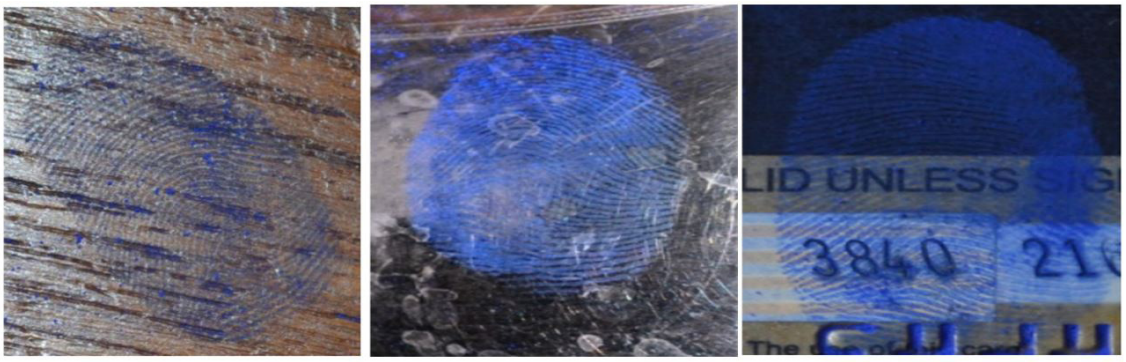
Table 2: Most effective method for various surfaces. Based on information collected from [13,16,18-20]

Cyanoacrylate Fuming

Super glue technique used for development of prints is a fuming procedure. The principle means that when the alkyl 2- cyanoacrylate reagent is vaporized, it basically gets (base-catalysed) polymerized [15]. This polymerized ester has a tendency to get attached to the sweat molecule giving a visible appearance to the ridge pattern [15]. Even though it is a very effective and convenient technique, the prints formed are white in colour, lacking contrast. Therefore, to enhance the colour, the prints can be dusted with a dye like crystal violet. On exposure to UV (Ultraviolet) these dyed prints show sharp contrast. This technique is usually used to develop prints on non-porous surfaces like glass which are submerged in water for a long duration [13]. The advantage of this technique is that it develops moderate quality prints even if the rate or duration of submersion is high. Cyanoacrylate Fuming showed the best results for metal and glass surfaces with a visibility score of 3-4 after long duration (10days) of submersion in the aquatic environment [13]. Most of the methods don't develop prints on surfaces which are submerged under seawater for a longer time interval. But, CA Fuming developed few prints on seawater submerged surfaces as well.

Figure 2: Fingerprints developed on a glass surface using CA Fuming with a visibility score of 5. The figure is obtained from [13]

Robin Blue



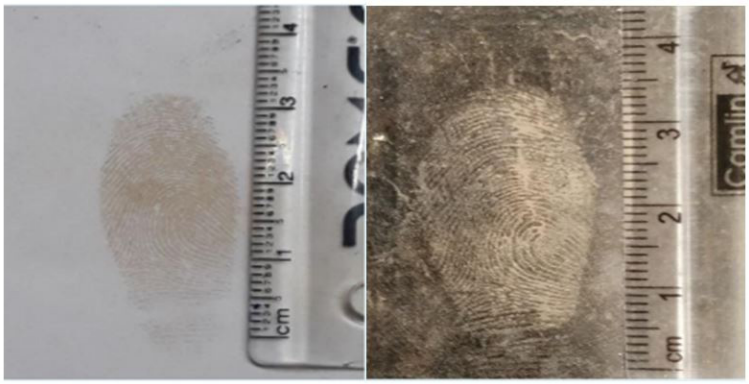
(a) **(b)** **(c)**

Figure 3: Shows developed latent finger-marks on surfaces **(a)** wooden surface; **(b)** silver surface and **(c)** back of a credit card {magnetic strip}. The figures are obtained from [20]

It is seen that adherence of physical powder to the print is dependent on the size of particle used for the purpose of development. Higher the particle sizes, higher are the chances that the prints will be obstructed. Since the development is proportional to the fineness of the particle, therefore, the use of robin blue powder is suggested [9]. Robin blue is basically a post wash whitening agent known as kneel. It produces violet coloured prints on non-porous surfaces like silver coin, credit cards (aluminium) and wooden plank [9]. It always produces clear prints for the above mentioned surfaces. A study was conducted to compare Robin Blue and Silver Magnetic Powder (SMP) Methods [16]. The study ended up in proving that Robin Blue was a much more effective method in comparison to SMP. Especially when it came to developing prints on a surface like aluminium foil. Nil prints were developed on the foil surface using SMP [16]. But the use of Robin Blue method developed prints on the aluminium foil surface although the succession number was poor but the visibility was still good. In addition, the visibility score and succession rate (number of prints developed) of Robin Blue was also higher [16].

Rock Phosphate Powder

Rock phosphate powder being a non-toxic method is one of the easiest techniques available. The use of fine dust of this powder is usually involved when it comes to the detection of latent finger impressions. The principle involves attachment of the dust portion to the fatty acids and oily component present in the sweat of the left finger mark at the scene of crime. These fingerprints get visible on dusting the powder which results in development of sharp contrast marks. In general, Rock phosphate powder can be applied to detect prints on porous as well as non-porous surfaces [18]. Various studies have suggested that this powder is best suitable for surfaces like paper, granite. One of the Research studies concluded that rock powder gives good results on most of the surfaces with clear fingerprint patterns and ridges and the visibility score lies in category of 3 for surfaces like porous plastic.



(a) **(b)**

Figure 4: (a) Detectable developed latent fingerprints on Paper surface with Rock Phosphate Powder; **(b)** Developed latent fingerprints detected on Granite surface by Rock Phosphate Powder Technique. The figures are obtained from [18]

Different coloured Soil forms

(a) **(b)**

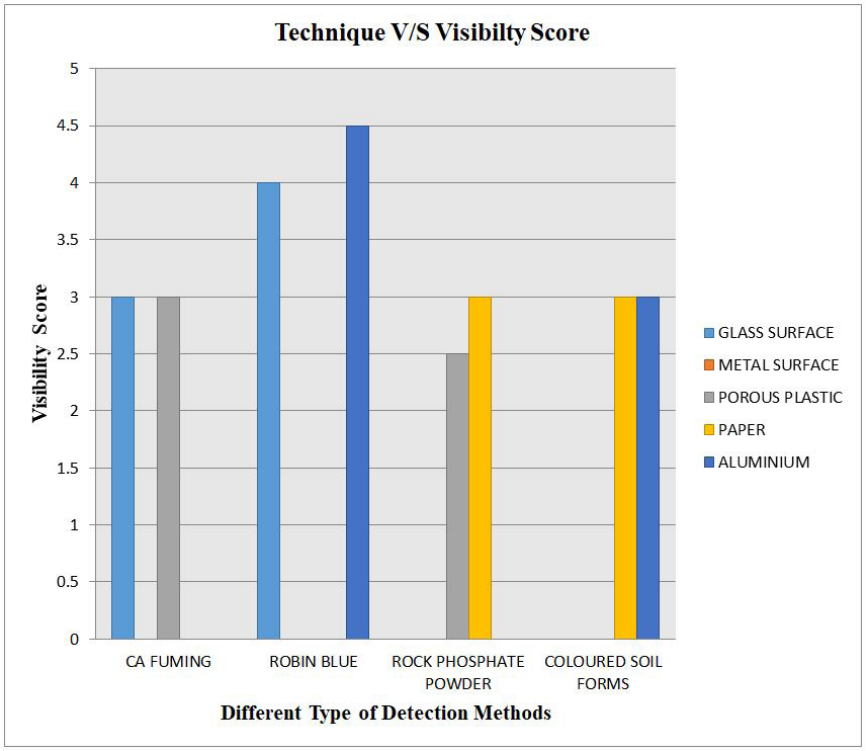
Figure 5: (a) shows development of latent fingerprints on green or red plastic surface by White form of soil powder; **(b)** shows developed latent fingerprints on car bonnet surface by detection technique, Red form of soil powder. Both forms of soil show good ridges. The photomicrographs are obtained from [19]

Generally, some of the techniques (like ferric oxide powder) applied for the development of fingerprints involves use of hazardous chemicals or substances that can negatively impact the human health. To avoid and reduce the exposure of such harmful chemicals to humans, a new method has been established /generated. This method involves the use of non- toxic, easily available different coloured soil samples. These samples are based on a similar principle; attachment of the dust to the glycerol or fatty acid molecule present on the sweat. This attachment results in the formation of visible ridge patterned marks [19]. The different coloured powders are namely: white, red and brown. Selection of coloured soil form depends on the type of surface material found as evidence. For example, for a green /red coloured plastic surface we use a white coloured powder and red soil for car bonnet surface. Use of different coloured soil forms resulted in formation of good quality prints because of abidance of soil powders to the invisible finger impressions. The reason for this abidance is the non-covalent bond formation between the powder and the finger-mark [19].

Comparison between Methods

A comparative study showed that prints recovered from materials submerged in fresh water produced significantly higher mean visibility scores than those submerged in sea water for equivalent time intervals using various methods of development (like black powder, cyanoacrylate, and small particle reagent) [16].

The following graph shows the comparison between the qualities of prints produced via these methods.



NOTE: Some of the surfaces were submerged under aquatic environment for a long interval of time (say around 10days) mainly, in case of CA Fuming.

Graph 1: Visibility Score versus Methods namely CA Fuming, Robin Blue, Rock Phosphate Powder and coloured soil forms for Different Surfaces namely Glass surface, Metal surface, Porous Plastic surface, Paper surface and Aluminium surface. Information referred from [13,16,18-20]

Conclusion

It can be concluded that any part of proof regenerated from water should be examined for finger- marks, irrespective of the duration of time it was submerged. Fingerprints if found can lead the investigation in a new direction. These developed prints provide significant individual characteristics about the offender. These Fingerprints can be recovered from surfaces submerged in aquatic environment. For this purpose cyanoacrylate provides the visualization. Phosphate rock powder and robin blue powder provide a good contrast in comparison to other chemical or non-chemical powders [18]. Variety of soil sample samples of different colours are available everywhere, and they also provide good contrast. Being non- toxic and very simple in nature, they can be used to develop fingerprints [19]. In recent years, researchers have developed and improved these detection techniques. However, there is still a lot of advancement which can happen in this field of science. More research in this area could improve the sensitivity and quality of the development of latent fingerprint by a variety of methods on different coloured surfaces. Studies have shown seawater has a more prominent and permanent damaging effect on development of fingerprints. The reason is probably high salinity, but more research could throw light on the subject [12]. Based on the studies, the conclusion is reached that specific methods should be used to produce good fingerprints qualitatively and quantitatively.

References

1. Ifs Study of Fingerprints (Dactyloscopy), Forensics Sciences (Inc: Forensic Science & Criminology), India.

2. Garg RK, Kumari H, Kaur RA (2011) New technique for visualization of latent fingerprints on various surfaces using powder from turmeric: A rhizomatous herbaceous plant (Curcuma longa). Egy J Foren Sci 1: 53-7.

3. Joshi K, Kesharwani L (2015) Development Of Latent Fingerprints From Non Porous Surfaces Submerged In Water At Different Interval Of Time Using Two Spr Formulations. Int J Software Hardware Res Engin 3.

4. Azman AR, Mahat NA, Wahab RA, Ahmad WA, Huri MM (2019) Relevant visualization technologies for latent fingerprints on wet objects and its challenges: a review. Egy J Foren Sci 9: 10.1186/s41935-019-0129-3.

5. Kasper S (2016) Latent Print Processing Guide. (1st Edn) Elsevier, USA.

6. Hanson D (2006) Improved Fingerprint Acquisition: Law and Order, India.

7. Sodhi GS (2016) Physical developer method for detection of latent fingerprints: A review. Egy J Foren Sci 6: 44-7.

8. Smith B (2021) AZO NANO - How are Latent Fingerprints Developed using Nanomaterials? USA.

9. Kumar P, Tyagi S, Sirav K (2017) Recent Advancement in Development of Latent Fingerprints by Various Physical Methods: A Review. Int J Res Appl Sci Engin Technol 5.

10. Castello A, Frances F, Verdu F (2013) Solving underwater crimes: Development of latent prints made on submerged objects. Sci Justice 53: 328-31.

11. Devlin BE (2021) Mason Archival Respository Service, India.

12. Kallumpurat A, Kudtarkar A (2018) Development of Latent Finger Prints from Porous and Non-Porous Substances Disposed In Water. J Forensic Sci Crimi Inves 10.

13. Madkour S, Abeer Sheta, El Dine FB, Elwakeel Y, AbdAllah N (2017) Development of latent fingerprints on non-porous surfaces recovered from fresh and sea water. Egypt J Forensic Sci 7: 3.

14. Soltyzewski I, Moszczynski J, Pepinski W, Jastrzebowska S, Makulec W (2007) Fingerprint Detection and DNA Typing on Objects Recovered from Water. J Foren Identification 57: 681-7.

15. Stow K, Mcgurry J (2006) The recovery of finger marks from soot-covered glass fire debris. Sci Justice 46: 3-14.

16. Kapoor N, Ahmed S, Shukla RK, Badiye A (2019) Development of submerged and successive latent fingerprints: a comparative study. Egyptian J Foren Sci 9: 10.1186/s41935-019-0147-1.

17. Bumrah GS, Sharma RM, Jasuja OP (2016) Emerging latent fingerprint technologies: a review. Res Reports Foren Med Sci 6: 39-50.

18. Sankhla MSKR (2018) Crime Investigating Technique to Development of Invisible Fingerprints on Surfaces using Rock Phosphate Powder. Int J Foren Sci 3: 000133.

19. Kamble DB (2019) A New Powder Method For Development Of Latent Fingerprint.

20. Badiye A, Kapoor N (2015) Efficacy of Robin® powder blue for latent fingerprint development on various surfaces. Egyptian J Foren Sci 5: 166-73.

21. Sodhi GS, Kaur J (2009) Detection of latent fingerprints: a review. The Ind Police J 120: 172-6.