Development of Submerged Latent Fingerprints on Non-Porous Substrates with Activated Charcoal based Small Partical Reagant

Kavleen Kaur[1], Tina Sharma[2], Ridamjeet Kaur[2]

[1]M.Sc Student, [2]Assistant professor, Department of Forensic Science and Toxicology, Chandigarh University, Gharuan, India

Abstract

The practice of using small partial reagent (SPR) for the visual development of latent fingerprints is the preferred choice, particularly concerning wet surfaces. In the present study, non-porous surfaces impinged with latent prints submerged in the water simulating acidic basic and salty water bodies were developed with activated charcoal based small particle reagent method. As evident from the observations, the activated charcoal-based SPR method was able to develop latent fingerprint submerged on the glass surface for up to 11 days and on aluminium substrate, up to 12 days but the quality of fingerprint observed was better on the glass substrate. The shelf life of the activated charcoal-based SPR method was found to be 52 days. The results have shown that the time-lapse of submersion and quality of fingerprint developed are inversely prepositional to each other. Although pond water submerged substrates showed good quality developed fingerprints for a longer period than other mediums but with increasing period of submersion the quality degraded.

Keyword: *Forensic Science, Fingerprint visualization, SPR, Small particle reagent, latent fingerprint development.*

Background

Fingerprints are formed by chemical and biological components present on the friction ridged skin [1]. Different techniques for the visualization of latent fingerprints have been established to obtain clear ridge details [2]. The choice of a specific technique for a specific substrate is advisable for the visualization of the latent fingerprint. The fingerprint residue constitute two types of components i.e. water-soluble components and non-water-soluble components depending upon the availability of the above-mentioned component at specific time and substrate, the choice of visualization method should be undertaken. The Visualization of latent fingerprints on wet submerged objects is quite difficult. Most of the previously tested methods demonstrate effective development with dry substrates. The development of latent fingerprints on wet porous substrates is one of the very difficult unsolved scientific problems. The use of Ninhydrin, DFO, and silver nitrate could not detect these latent prints on such surfaces, as the development of these type of fingerprints are mostly dependant on non-water-soluble components and the above-mentioned techniques mostly work with water-soluble components of fingerprints [3-7]. In contrast to that, the probability of developing latent marks containing lipid / Non-water-soluble components left on the substrate is quite high concerning the SPR method. Some research studies have attempted to study various technical aspects of developing latent fingerprints on submerged surfaces. From the perusal of literature, it was observed that there is existence of direct correlation between choice of developing reagent, type of latent component(WSC or NWSC) present, type of substrate

Corresponding Author:
Tina Sharma,
Assistant Professor, Department of Forensic Science and Toxicology, Chandigarh University, Gharuan, India, 140413
Email: sharmatina1989@gmail.com,
Sharma.tina@cumail.in

on which latent fingerprint is present, time since submersion of latent fingerprint and nature of medium in which the submerged latent fingerprint is studied. The Visualization of latent fingerprints on underwater surfaces had been tried for eccrine rich and sebaceous rich marks with small particle reagent (black and white), Oil Red O, Sudan Black and gentian violet methods and cyanoacrylate on various substrates like glass and metal surfaces [7-9]. The results suggested the positive visualization of sebaceous-rich marks in comparison to eccrine-rich marks. It relies on the adhesion between sebaceous components present in traces and the hydrophobic tails of the reagent. The suspension is generally applied by immersion or spraying methods [10]. Very less work has been carried out on latent fingerprint development on submerged surfaces and effects of different mediums like pond water, salty, basic and acidic water on latent print visualization particularly with activated charcoal-based SPR. Henceforth the main goal of the present research work was to carry out the comparative analysis of small particle reagent to develop fingerprint submerged in different media concerning time-lapse and quality of the fingerprint developed.

Materials and Methods

Working solution formulation: Small particle reagent was prepared using activated charcoal black powder (Kerala Naturals). The suspension solution was prepared by dissolving 5 grams of activated charcoal in 75 ml of distilled water with the addition of 3 drops of surfactant (commercial liquid detergent).

The study was conducted in the month of summer season with a temperature range between 25ºC to 40 ºC and relative humidity between 15-40%

Simulation of Sea Water:

23.39 grams of NaCl was dissolved in 1 liter of distilled water. To the prepared solution, KCl (0.715grams), $MgCl_2$ (10.633 grams), $CaCl_2$ (1.455grams), Na_2So_4 (4g) and Tris base (2.4 g) was added [6]. The solution was stirred with the help of magnetic stirrer for 1 hour and the pH of the solution was maintained 8 to 8.2 throughout the experiment.

Simulation of lake water Acidic:

To acidic simulate lake water pH of 11 distilled water was maintained near 5.5 to 7 with the help of HCl and NaOH solutions

Simulation of lake water Basic:

The deeper lakes with stratification constitute pH range slightly higher than neutral freshwater. To simulate lake water pH of 11 distilled water was maintained near 7.5 to 9 with the help of HCl and NaOH solutions

Muddy water:

The muddy water was collected from a natural pond, Mohali Punjab with pH 6

Sample Preparation: In the present study, five individuals were asked to deposit latent fingerprints on non-porous substrates like aluminium foil and glass slide. The fingerprints were immersed in different mediums like salty water, muddy pond water, acidic and basic lake mediums. These mediums were used to simulate the different conditions with respect to water bodies like the sea, ditches, drainage, etc where the offender could try to dispose of the evidence.

Visualization of Latent Fingerprints: 20 sets of each substrate i.e glass slide and aluminium foil containing latent fingerprints were immersed in 4 mediums. Each substrate was taken and sprayed with SPR formulation every day till viable results were available. The SPR was allowed for 1 min to react with the wetted latent fingerprint, which was then washed with distilled water to remove excess reagent then dried for photography. The composition of the developing reagent was tested under laboratory conditions. The shelf life of regent was observed to be about 52 days.

Results

The fingerprint score was accessed using (Soltyszewski et al. 2007) fingerprint quality assessment scale [11]. Fig-1 showcased the score with respect to the quality of fingerprints obtained. As evident from the observations, among all the mediums the best results were obtained in muddy medium on by aluminium foil followed by a glass slide. The SPR based reagent gave results on glass slide up to 5 days and on aluminium foil 8 days though a significant decline in quality of fingerprints was observed due to deposition of mud on print in subsequent days. The shelf life of SPR reagent was observed to be 52 days.

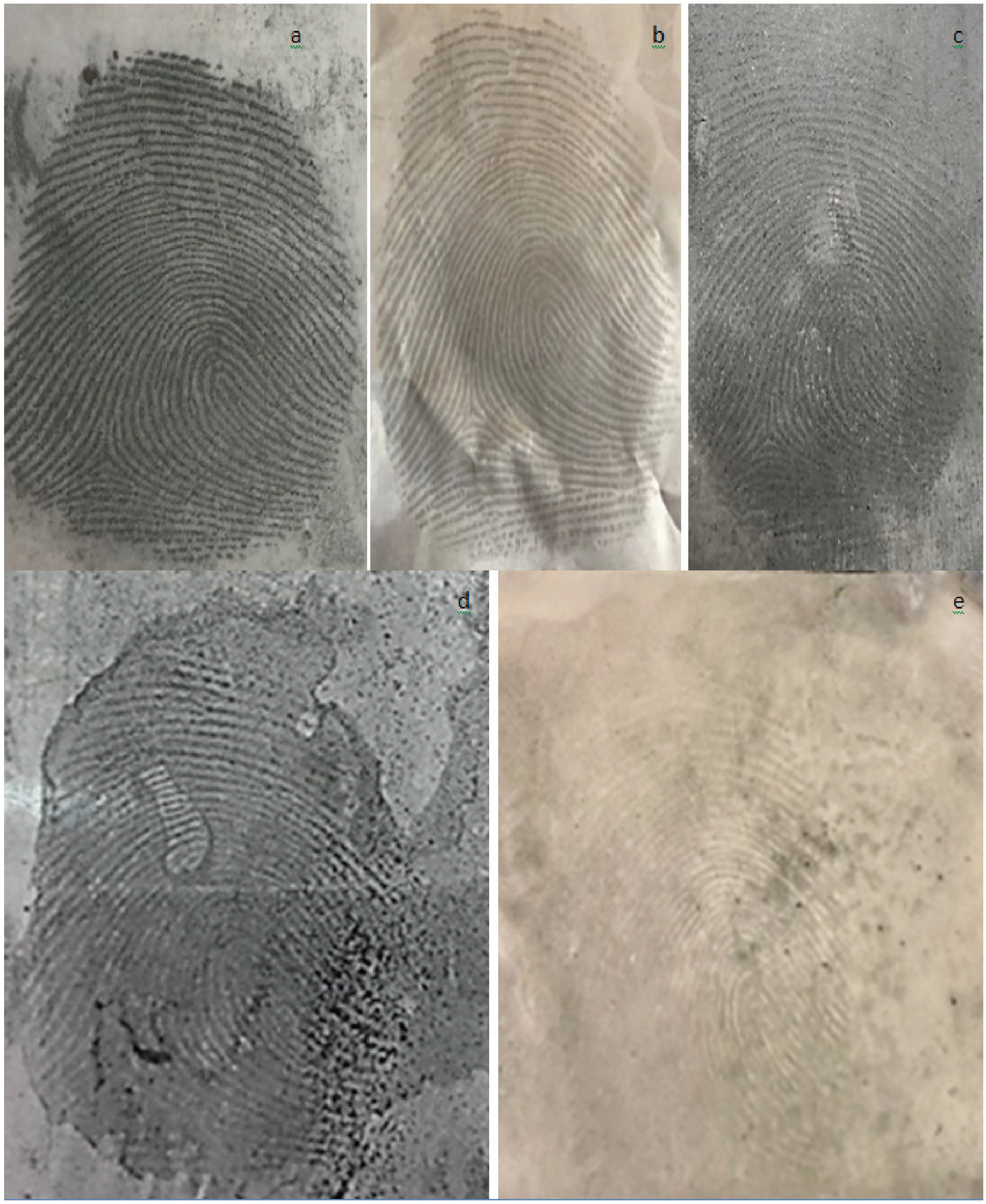
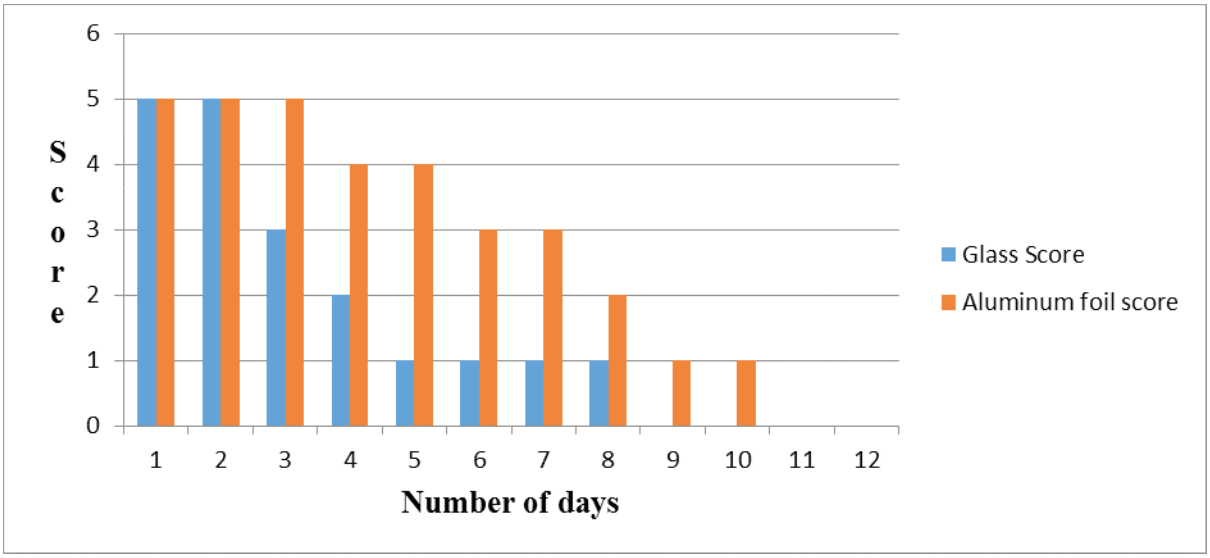


Fig 1- Quality of Fingerprints depicted grade wise (a) Grade 5 (very good quality) (b) Grade 4 (Good quality) (c) Grade 3 (Poor quality) (d) Grade 2 (Bad quality) (e) Grade 1 (Blur quality)

Simulated Sea water

Graph-1 shows very good quality fingerprints up to 3 days on aluminium foil followed by good quality fingerprints up to 5th day. Poor quality fingerprints were observed on the 6th to 7th day. On 8th-day bad quality fingerprints were observed followed by blur fingerprints on 10 and 11th day of observation. No fingerprints were observed on the 12th day.



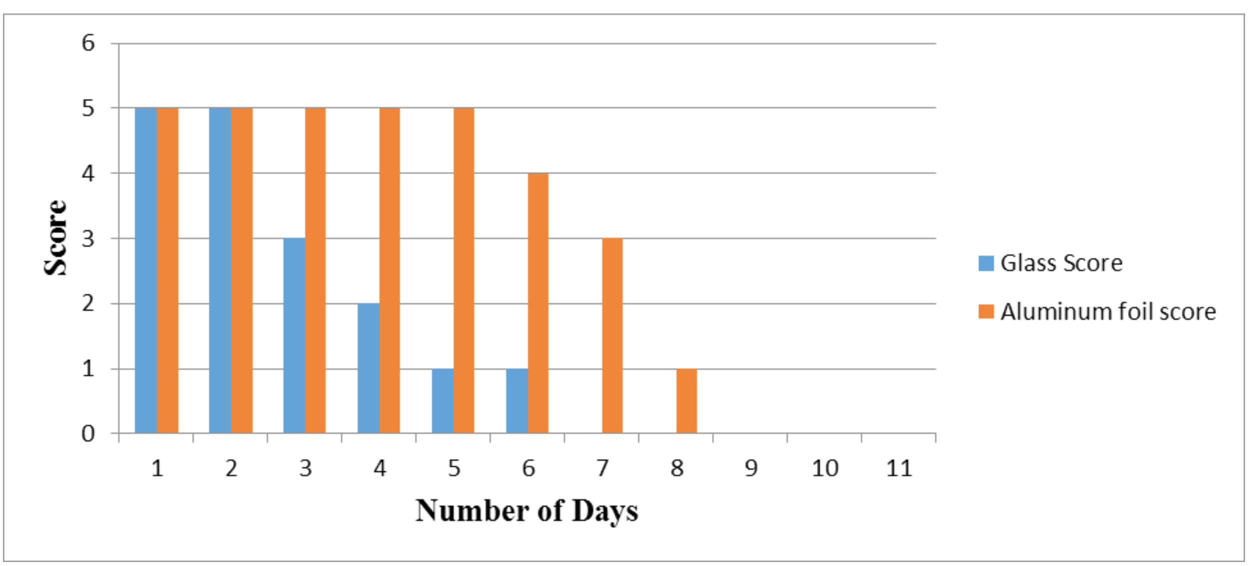
Graph 1- Developed fingerprint quality index depicted till day 12 on aluminium and glass surfaces submerged in simulated Sea water

On the glass substrate, high-quality marks were developed up to 2nd day of submersion in the medium. Poor to bad quality marks were obtained from 3rd to 4th day of submersion and blur fingerprints were observed between 5th day onwards until day 8. No fingerprints were observed on 9th day.

Salty water has a destructive effect on the quality of fingerprints due to its salinity thus the quality of fingerprint declined rapidly with an increasing period of submersion. So clear ridge density can be observed till day 5 in case of aluminium and day 2 in case of the glass substrate.

Simulated Lake water Acidic

Graph- 2 shows very good quality fingerprints were developed on aluminium foil up to 5 days of submersion, followed by the good quality on day 6th, poor quality on day 7 and blur fingerprints were obtained on day 8. No fingerprints were observed on the 9th day onwards.

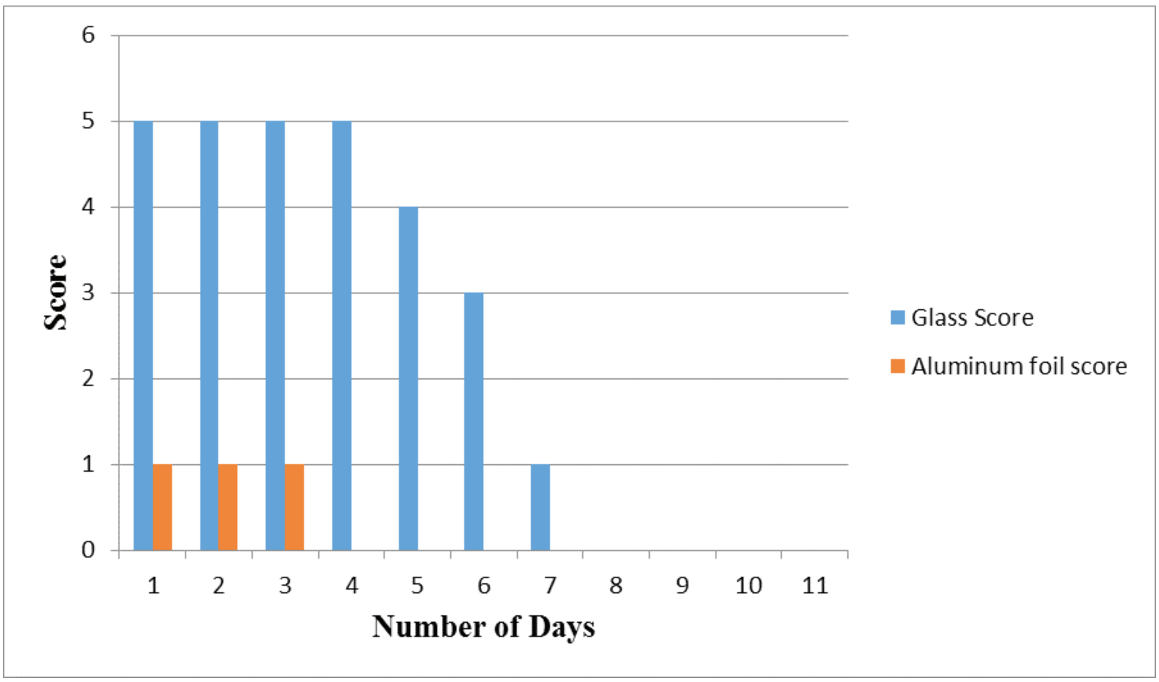


Graph 2- Developed fingerprint quality index depicted till day 11 on aluminium and glass surfaces submerged in simulated acidic lake water

On glass slide very good quality was developed up to 2 days of submersion in the medium and poor and bad quality fingerprints were developed between 3rd – 4th days. Blur fingerprints were recorded on the 5th -6th day. After 6th day no fingerprint visualization was observed. The quality of the fingerprints declined significantly with an increasing period of submersion because of the destructive effect of acid. Aluminium showed good viable results till day 6 in contrast to the glass substrate which showed comparable fingerprints only up to 2nd day of observation.

Simulated Lake water Basic

Graph-3 shows blur fingerprint Visualization up to 3 days of submersion and it was recorded that the aluminum foil degraded in the medium because of the corrosive action of NaOH

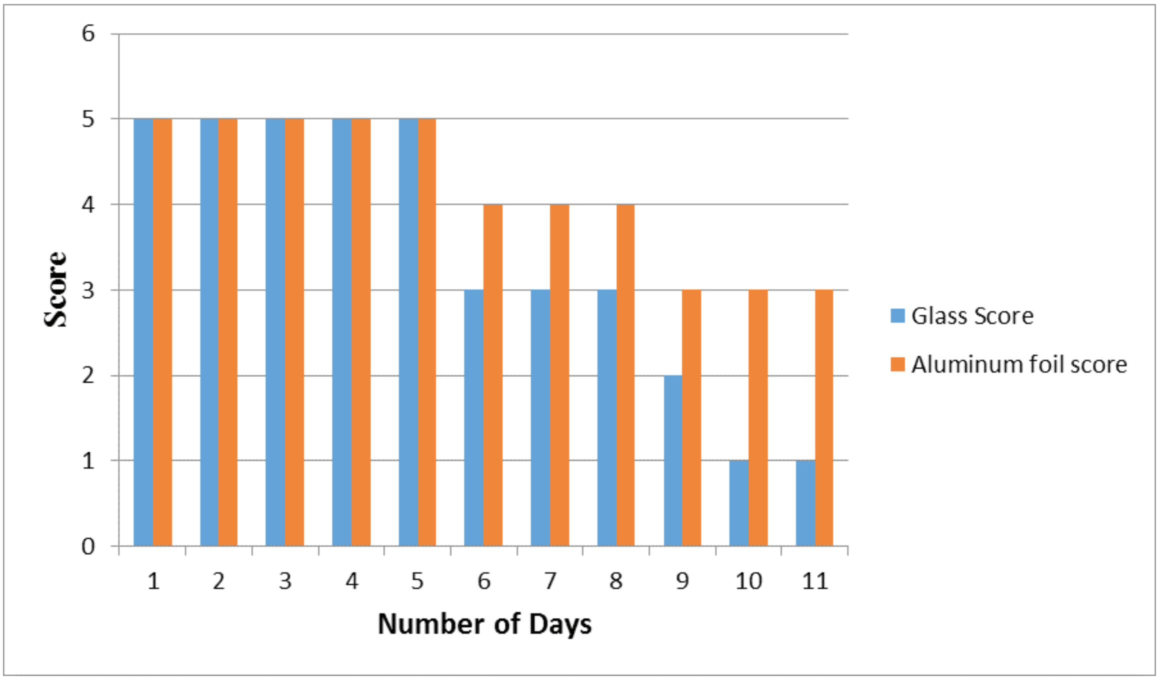


Graph 3- Developed fingerprint quality index depicted till day 11 on aluminium and glass surfaces submerged in simulated basic lake water

Good quality fingerprints were obtained up to the 4th day of submersion followed by the good quality on the 5th day. Poor and bad quality fingerprints were observed on the 6th to 7th day. Very blur fingerprints were observed on the 7th day. Afterward, no fingerprint Visualization was possible. On the glass surface, high-quality fingerprints were obtained up to 4th days of submersion. No comparable fingerprints could be obtained on aluminium foil.

Pond water

Graph-4 shows the comparative analysis of fingerprints concerning the number of days successful Visualization of the latent fingerprint was observed. Out of the four mediums, pond water submerged latent fingerprints on aluminium substrate showed very good quality fingerprints up to 5 consecutive days, followed by good quality fingerprints up to 9th day and 10th day showed poor quality fingerprint. Although fingerprints got developed on 11th and 12th day yet very bad quality was observed. In the case of glass substrate high-quality fingerprints were observed up to 4th day, 5th-day good quality a shown in Fig-9 followed by 6th-8th day poor quality fingerprints were observed. Very blur fingerprints were observed on 10 and 11 days, yet on 12th day no fingerprint was observed.



Graph 4- Developed fingerprint quality index depicted till day 11 on aluminium and glass surfaces submerged in Pond water

SPR reagent on aluminium foil gave high quality marks up to 8th days as shown in fig and

Glass surface gave fairly good results up to 4th days as shown in Fig-1 with clear distinct ridges and medium quality marks were obtained from 6-8 days.

Discussion

The present examination uncovered the possibility of developing scores 4 and 5 quality fingerprints from submerged substrates. Usually, the weapon of crime is disposed of in nearby water bodies in order to destroy the possibility of identification. (Soltyszewski et al., 2007). In this present work, an SPR based reagent has been used to develop latent fingermarks on non-porous substrates soaked in a different medium, (muddy water, salty water medium, acidic medium and basic medium)[11]. As evident from the observations, among all the mediums the best results were obtained in pond water from aluminium foil followed by a glass slide. The SPR based reagent gave good quality results on glass slide up to 5 days and on aluminium foil 8 days. Afterward, though a significant decline in the quality of fingerprints was observed due to the deposition of mud on print in subsequent days.

As the time-lapse increased, the quality of latent fingerprints developed with SPR decreased. It may be because of the degradation of fatty deposits on latent fingerprints with a persistent stay in the water (Cadd et al., 2015)[12]. Basically in the SPR method lipid components of latent fingerprints are utilized to develop visualized fingerprints (Girod et al., 2012)[13]. The small particles of charcoal in the presence of surfactant is adsorbed on the fatty residues of latent prints thus visualizing latent prints, with time these deposits deteriorate thus resulting in bad quality fingerprints[14]. Soltyszewski et al., 2007 used different methods to visualize latent fingerprints on submerged surfaces. This study utilized aluminum powder, ferromagnetic powder, and superglue fuming for the development of fingerprints with aluminum. A on glass slides submerged in river, sea, tap, or distilled water and still alike inferences were drawn regarding the relationship between submersion time and quality of developed fingerprint despite the method used. The study also mentioned the significance of temperature as decreased temperature resulted in good quality fingerprints for a longer period of time [11].

Trapecar 2012 conducted a similar study on glass and metal substrates submerged in stagnant water with aluminum powder, ferromagnetic powder, and CA, the study concluded cyanoacrylate fuming as the best method for fingerprint visualization[5]. In contrast to Trapecar 2012, the present study showed charcoal-based small particle reagent is the best method for visualization of fingerprints on aluminium and glass substrates submerged in pond water. The nature of water has a direct effect on the development process of fingerprints, concerning different substrates. Highly saline water causes serious damage to latent fingerprints which can be inferred from the quality of the prints developed. In the present study, good quality prints were observed up to day 5 on the aluminium substrate in comparison to the glass which showed good results only for two days.

Conclusion

The likelihood of developing latent fingerprints on submerged surfaces has been validated in the present research study with activated charcoal-based Small particle reagent. The study validated the relationship of time-lapse and quality of fingerprints, as with increasing time duration the quality of fingerprints deteriorates. The best results for a longer duration were observed on pond water. The acidic and basic medium lake water showed mixed results and suggested a straight association between the substrate on which latent fingerprint is being developed and the pH of the water. With increasing pH, the clarity of fingerprints on aluminium foil decreases, in contrast to that, with decreasing pH quality of latent fingerprint visualization increases. The results suggested the positive visualization of sebaceous-rich marks in comparison to eccrine-rich marks and studies also revealed the clarity of marks is directly correlated to the time since submersion and type of substrate on which latent fingerprints are present.

Ethical Clearance- Not required

Source of Funding- Self

Conflict of Interest- Nill

References

1. Frank A, Almog J. Modified SPR (small particle reagent) for latent fingerprint development on wet, dark objects. J Forensic Ident. 1993; 43(3):240-4.
2. Cuce P, Polimeni G, Lazzaro AP, De Fulvio G. Small particle reagents technique can help to point out wet latent fingerprints. Forensic science international. 2004; 146: S7-8.
3. Rohatgi R, Kapoor AK. Development of latent fingerprints on wet non-porous surfaces with SPR based on basic fuchsin dye. Egyptian Journal of Forensic Sciences. 2016; 6(2):179-84.
4. Jasuja OP, Kumar P, Singh G. Development of latent fingermarks on surfaces submerged in water: Optimization studies for phase transfer catalyst (PTC) based reagents. Science & Justice. 2015; 55(5):335-42.
5. Trapecar M. Fingerprint recovery from wet transparent foil. Egyptian Journal of Forensic Sciences. 2012; 2(4):126-30.
6. Madkour S, El Dine FB, Elwakeel Y, AbdAllah N. Development of latent fingerprints on non-porous surfaces recovered from fresh and sea water. Egyptian journal of forensic sciences. 2017; 7(1):3.
7. Bumbrah GS. Small particle reagent (SPR) method for detection of latent fingermarks: A review. Egyptian Journal of Forensic Sciences. 2016; 6(4):328-32.
8. Kapoor S, Sodhi G, Sanjiv K Visualization of Latent Fingermarks using Rhodamine B: a new method. Int J Forensic Sci Pathol. 2015; 3(11):199–201, http://scidoc.org/articlepdfs/IJFP/IJFP-2332-287X-03-1101.pdf
9. Lee HC, Gaensslen RE Methods of Latent Fingerprint Development. In: Lee HC, Gaensslen RE (eds) Advances in Fingerprint Technology, 2nd edn. 2001; CRC Press, Boca Raton
10. Croxton R, Baron M, Butler D, Kent T, Sears V. Variation in amino acid and lipid composition in latent fingerprints. Forensic Sci Int 2010; 199:93–102
11. Soltyszewski I, Moszczynski J, Pepinski W, Jastrzebowska S, Makulec W, Janica J. Fingerprint detection and DNA typing on objects recovered from water. 2007; JFI 57(5):681–687
12. Cadd S, Islam M, Manson P, Bleay S Fingerprint composition and aging: A literature review. Sci Justice 2015; 55(4):219–238
13. Girod A, Ramotowski R, Weyermann C. Composition of fingermark residue: a qualitative and quantitative review. Forensic Sci Int 2012; 223:10–24
14. Mong G, Petersen C, Clauss T. Advanced fingerprint analysis project fingerprint constituents, Technical Report 1999; 22.