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Farklı Türde Taş Yüzeyler Üzerindeki Parmak İzlerinin Zamana Bağlı Değişiminin İncelenmesi
Identification of Fingerprints on Different Kinds of Stones on the Basis of Time

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IDENTIFICATION OF FINGERPRINTS ON DIFFERENT KINDS OF STONES ON THE BASIS OF TIME

Abstract

Fingerprints are one of the most important types of evidence in crime investigation due to their permanency, uniqueness, and ease of enhancing. Demonstrators usually prefer hiding their identities by covering their faces in illegal events such as throwing stones at security forces or at businesses and residences so as to damage property. Once the fingerprints are detected on stones, it could be possible to reach the perpetrators. However, there is insufficient research about recovering fingerprints on stones and their subsequent reliability. In this study, fingerprints left on 12 different kinds of stone surface were held for 1, 3, and 5 days respectively, after which it was sought to determine whether or not suitable fingerprints could be recovered for comparison. In this study, As a result of various chemical applications in the laboratory on 12 different types of stones, it was revealed that fingerprints with sufficient characteristics could be obtained from various stone types. Fingerprints of good quality were made visible with cyanoacrylate fuming method, particularly on stones with smooth surfaces and minimal porosity such as the outer surfaces of red brick, marble, mosaic, ceramic, tile and granite. After more than a hundred and thirty years, fingerprints still remain to be considered as one of the most important sources of evidence. It is evaluated that fingerprints developed from stones which were thrown during an assault could be instrumental in identification of a perpetrator.

Keywords: *Fingerprint, stone, Cyanoacrylate, Silver nitrate, Ninhydrin.*

FARKLI TÜRDE TAŞ YÜZEYLER ÜZERİNDEKİ PARMAK İZLERİNİN ZAMANA BAĞLI DEĞİŞİMİNİN İNCELENMESİ

Öz

Parmak izleri benzersizlik, değişmezlik ve geliştirilme kolaylığı özellikleri ile suç soruşturmasının önemli delillerindendir. Yasa dışı olaylarda güvenlik güçlerine taş atma, mala zarar verme amacıyla iş yerlerine ve konutlara taş fırlatma gibi olaylarda göstericiler genellikle yüzlerini kapatarak kimliklerini gizleme yoluna gitmektedir. Bu tür olaylarda taşlar üzerinden parmak izleri elde edilebilirse suçun failine ulaşmak mümkün olabilecektir. Bunula birlikte taşlar üzerinden parmak izlerinin elde edilmesine ve izlerin geliştirilme yöntemlerine ait yeterli çalışma bulunmamaktadır. Bu çalışmada 12 farklı taş yüzey üzerinde bırakılan parmak izleri sırasıyla 1, 3 ve 5 gün süreyle bekletilmiş, ardından karşılaştırma için uygun parmak izlerinin bulunup bulunamayacağı incelenmiştir. Laboratuvarda 12 farklı taş türü üzerine çeşitli kimyasal yöntemler uygulanarak taş türlerinden yeterli özellikte parmak izlerinin elde edilebileceği ortaya konmuştur. Siyanoakrilat yöntemi ile özellikle kırmızı tuğla, mermer, mozaik, seramik, fayans ve granit gibi dış yüzeyleri düzgün ve minimum gözenekli olan taşlarda, kaliteli parmak izlerinin görünür hâle getirilebileceği tespit edilmiştir. Çalışmanın yasa dışı gösteriler sırasında atılan taşlardan elde edilen parmak izlerinin failin tespit edilmesine katkı sağlayacağı sonucuna ulaşılmıştır.

Anahtar Sözcükler: *Parmak izi, taş, siyanoakrilat, gümüş nitrat, ninhidrin.*

INTRODUCTION

Throughout history, stones have been used as implements of offence and defense. Stones are frequently used in burglaries, riots against police and military forces in many countries. In Turkey, this can also be an issue, specifically where illegal demonstrators, often hurt law enforcement personnel and citizens and damage shops or business offices by throwing stones. Since the illegal demonstrators generally hide their faces in these kinds of events, their identity can often not be specified. Fingerprints are one of the important types of evidence in crime investigation due to their permanency, uniqueness, and ease of enhancing (Saferstein, 2017; Fisher and Fisher, 2012; Yadav, 2019). One possible method to identify the illegal demonstrators described above could be their fingerprints left on the stones used. Stones such as granite, basalt or limestone differ from each other in terms of their historical formation, composition, colour, texture and structure (Prinz, 1978; Davis, 2015). Different surface features of stones (such as porous-nonporous or pore sizes) are an important area of interest in forensic science research to develop an appropriate method for detecting the maximum fingerprint. However, there is a few research about recovering fingerprints on stones and their subsequent reliability (Hefetz, 2014; Liu 2019).

In this study, the contents of the files sent to the fingerprint examination laboratory regarding judicial events that occurred in 2018 were analyzed and it was identified that it could take between 1 to 5 days for evidence to arrive at the laboratory from the crime scene. It was therefore very important to analyze the influence of time on the recovery of the fingerprints from the stones. Fingerprints left on 12 different kinds of stone surfaces were held for 1, 3, and 5 days respectively, after which it was sought to determine whether or not adequate fingerprints could be recovered for comparison.

1. MATERIALS AND METHODS

For the purposes of this study; places where law enforcement had to engage and variety of stones that are easy to obtain for the protesters were selected in order to designate the stone types which will be examined to be as close as possible to reality. Protestors generally use stones against law enforcement that are readily available on the streets or that can be easily collected from properties nearby. Since they can be easily accessible at crime scenes, limestone, andesite, basalt, slate stone, white limestone, paving stone, red brick, marble, mosaic, ceramic, tile and granite were chosen for investigation.

1.1. Fingerprint Deposition

The fingerprints were placed on the stone half an hour after their hands were washed. The stones were split into three groups and left for different periods of time before fingerprint examination was carried out. Each group contained all twelve kinds of stones and the fingerprints were left by the same person on all three groups of stones. The groups were as follows;

1. Group Stones-1 day

2. Group Stones-3 days

3. Group Stones-5 days

1.2. Fingerprint Development

Considering the physical properties of the selected materials, cyanoacrylate fuming, silver nitrate and ninhydrin chemical fingerprint detection methods were considered to be suitable for fingerprint detection on the stones.

1.2.1. Cyanoacrylate Fuming Method and Application

The cyanoacrylate fuming method is a trace detection method used in the development of invisible fingerprints on non-porous surfaces. Cyanoacrylate polymerizes by reacting with amino acids in the fingerprint structure and makes the fingerprint become visible by taking a white color.

Considering that the selected materials generally have a non-absorbent structure in terms of their physical properties, the cyanoacrylate chemical trace determination method, which has one of the best results on non-absorbent surfaces, was chosen. Another reason for choosing the cyanoacrylate chemical tracer method is that the colorant techniques can also be used after application. After cyanoacrylate colorant is applied, materials with different colors can be examined under "multi-wavelength light source" minimizing data loss due to contrast differences.

In order to make the fingerprints left on the stones with different structural features and surfaces visible under laboratory conditions, the stones were exposed to “cyanoacrylate” fumes for 60 minutes with 70 % humidity and 130 °C temperature in the cyanoacrylate fuming cabin. Thereafter, “rhodamine 6g” colouring method was applied to the stones in an attempt to make any fingerprints present visible under various wavelengths of an alternate light source.

1.2.2. Silver nitrate Fingerprint Detection Method and Application

Silver nitrate trace detection method is generally used on dry and porous surfaces. Chloride components in the eccrine secretion in the fingerprint structure react with silver nitrate, making the fingerprint visible. Silver nitrate trace detection method was chosen considering that some of the selected materials have porous structure due to their physical properties.

Initially, the silver nitrate working solution was prepared. Considering the condition of the materials subjected to silver nitrate application, the solution could be applied by wiping with a soft tipped brush, spraying or dipping (Lee and Gaensleen 2001). In this study, silver nitrate solution was applied by dipping method on the stones, based on their condition. The stones were then left to dry for 20 minutes in a dark environment.

After being dried, the stones were exposed to sunlight for 60 minutes. When the time was over, the surfaces of the stones were constantly checked and the application was terminated when the background of the fingerprints becoming visible started to blacken. Subsequently, the developed fingerprints, if any, was photographed and recorded.

1.2.3. Ninhydrin Fingerprint Detection Method and Application

Ninhydrin trace determination method is an effective trace determination method generally used in the development of fingerprints on porous surfaces. It enables the fingerprint residue to become visible by taking a colour from purple to orange through reacting with amino acids in the fingerprint structure. Considering that some of the selected materials have absorbent and porous physical structures, it was evaluated that it would be optimal to choose the ninhydrin trace determination method.

First, the working solution of Ninhydrin was prepared. As with silver nitrate solution, the Ninhydrin solution could be applied by wiping with a soft tipped brush, spraying or dipping. In this study, the Ninhydrin solution was also applied by the dipping method. The stones were dipped in the Ninhydrin solution for 5-10 seconds and then heated in a darkened oven at 80 ° C with 65% relative humidity. The development of the fingerprints was visually followed. The heating process was applied for rapid development of fingerprints on the stones. Fingerprint development on surfaces subjected to ninhydrin treatment can take days, or even weeks, if the surfaces are not subjected to heat and moisture. After checking the

surfaces at 60-minute intervals, fingerprints that became visible on the stones were recorded by photography.

1.3. Fingerprint Examination

Fingerprints made visible by the application of the selected methods were photographed with a Canon brand camera, transferred to the computer data base and evaluated in AFIS (Automatic Fingerprint Identification System). The following classification of fingerprints were established:

-Fingerprints with sufficient characteristics for comparison (fingerprints with 12 or more features that had been photographed and transferred to AFIS) were classified as A quality. (Clearly visible ridges with sufficient quality to see minutiae).

-Fingerprints with distinctive features but insufficient characteristics for comparison were classified as B quality. (Ridges that are slightly visible but not sufficient to perform an analysis in terms of minutiae positioning).

-Fingerprints which were vaguely obvious, but with no clear papillary ridges were classified as C quality. (No visible reaction between the reagent and the ridges).

RESULTS and DISCUSSION

2.1. The Results After Cyanoacrylate Chemical Fingerprint Detection Method Application

Fingerprints held for 1 day:

As a result of cyanoacrylate fuming method application, A quality fingerprints could be recovered from the surfaces of red brick, marble, mosaic, ceramic, tile and granite. Also, it was observed that the rhodamine 6g colouring method applied after cyanoacrylate fuming enhanced the visibility of the fingerprints, especially those which were located on surfaces with colourful backgrounds such as mosaic.

Fingerprints were also recovered on basalt, slate stone and paving stone, but they were insufficient for comparison due to lack of distinctive characteristics, and were therefore evaluated as B quality. In addition, it was observed that rhodamin 6g colouring method did not affect the quality of the fingerprints. Only vague fingerprint impressions were observed, with no papillary ridges, on the limestone, white limestone and andesite stones, and therefore classified as C quality.

Fingerprints held for 3 days:

As a result of cyanoacrylate fuming method application, A quality fingerprints could be recovered from the surfaces of red brick, marble, mosaic, ceramic, tile and granite. C quality fingerprints were left on the surfaces of basalt, slate stone, paving stone, limestone, white limestone and andesite.

Fingerprints held for 5 days:

As a result of cyanoacrylate fuming method application, B quality fingerprints could be recovered from the surfaces belonging to red brick, marble, mosaic, ceramic, tile and granite. C quality fingerprints were left on the surfaces of basalt, slate stone, paving stone, limestone, white limestone and andesite.

2.2. The Results After Silver Nitrate Chemical Detection Method Application

Fingerprints held for 1, 3, and 5 days

As a result of silver nitrate application, C quality fingerprints could be recovered from all surface types.

2.3. The Results After Ninhydrin Fingerprint Detection Method Application:

Fingerprints held for 1 and 3 days

As a result of ninhydrin fingerprint detection, B quality fingerprints could be recovered from the surfaces of red brick and limestone. Fingerprints did not develop on the surfaces of andesite, basalt, slate stone, white limestone, paving stone, marble, mosaic, ceramic, tile and granite (Figure 13-16).

Fingerprints held for 5 days

No fingerprints could be recovered from the surfaces of limestone, andesite, slate stone, white limestone, paving stone, red brick, marble, mosaic, ceramic, tile and granite as a result of the ninhydrin fingerprint detection method after 5 days. When it comes to the surfaces of basalt, slate stone, paving stone, limestone, white limestone and andesite, C quality fingerprints could be obtained (Table 1) .

Table-1. Fingerprint Quality Evaluation Table

Cyanoacrylate Method	1st day	3rd day	5th day	**Silver Nitrate Method**	1st day	3rd day	5th day	**Ninhydrin Method**	1st day	3rd day	5th day
Red Brick	A	A	A	*Red Brick*	C			*Red Brick*	B	B	N/D
Marble	A	A	A	*Marble*				*Marble*	N/D	N/D	N/D
Mosaic	A	A	A	*Mosaic*				*Mosaic*	N/D	N/D	N/D
Ceramic	A	A	A	*Ceramic*				*Ceramic*	N/D	N/D	N/D
Tile	A	A	A	*Tile*				*Tile*	N/D	N/D	N/D
Granite	A	A	A	*Granite*				*Granite*	N/D	N/D	N/D
Basalt	B	C	C	*Basalt*				*Basalt*	N/D	N/D	C
Slate Stone	B	C	C	*Slate Stone*				*Slate Stone*	N/D	N/D	C
Paving Stone	B	C	C	*Paving Stone*				*Paving Stone*	N/D	N/D	C
Limestone	C	C	C	*Limestone*				*Limestone*	B	B	C
White Limestone	C	C	C	*White Limestone*				*White Limestone*	N/D	N/D	C
Andesite	C	C	C	*Andesite*				*Andesite*	N/D	N/D	C

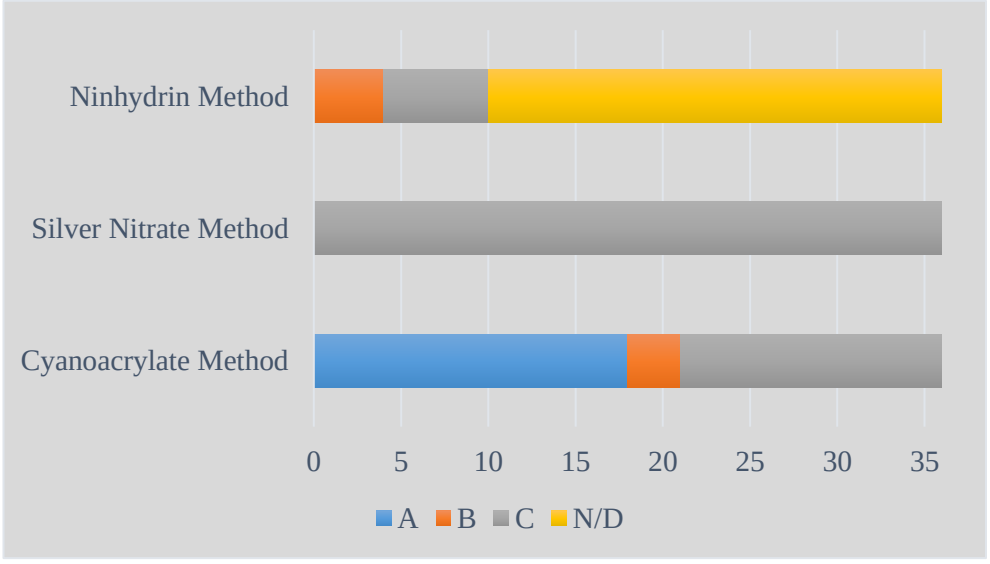

Fig-1. Fingerprint Quality Graph (Numeric)

CONCLUSION

In general, it is assumed that latent fingerprints on the stones cannot be detected. Even if it was considered to be possible for the purposes of this article, it would not help to lead a conclusive comparison (Donche and Loyan, 1996). Moreover, no study has been performed on the quality of fingerprints depending on the time elapsed. Results obtained via various methods of fingerprint collection within different periods of elapsed time are prescribed below;

The results after cyanoacrylate chemical fingerprint detection method application reveals that 'A' quality fingerprints could be recovered from the surfaces of red brick, marble, mosaic, ceramic, tile and granite. It was suggested that the reason for this result was due to rough surfaces of the stones along with porous and absorbent structure of the stone surfaces of limestone and white limestone on day 1. However, regarding fingerprints that are held for 3 days; Whilst 'A' quality fingerprints could be recovered from the surfaces of red brick, marble, mosaic, ceramic, tile and granite, diversely, 'C' quality fingerprints were left on the surfaces of basalt, slate stone, paving stone, limestone, white limestone and andesite. The results implied that the rough and porous formation of the stone surfaces, and the absorbent surfaces of others were the determining factors of the above stated conclusion. The results after silver nitrate chemical detection method application for fingerprints that are held for 1-3-5 days show that the silver nitrate method is appropriate and effective on surfaces of wooden objects or raw wood, which have soft and porous characteristics, rather than hard surfaces such as rock. Ninhydrin is generally an accepted method for absorbent and soft materials like paper. Therefore, the results of the fingerprint development after Ninhydrin detection method for finger prints which were held for 1-3 days on red brick and limestone revealed an unexpected result. This is a very important discovery for the detection of fingerprints on these types of stone surface (Figure 1-2).

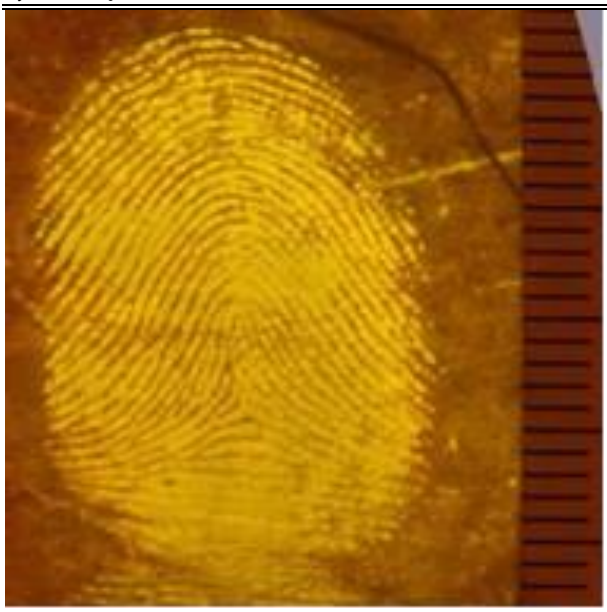

Fig-2. The İmage Of The Fingerprint On a Marble Surface After Cyanoacrylate Fuming Method Application After Holding For 1 Day

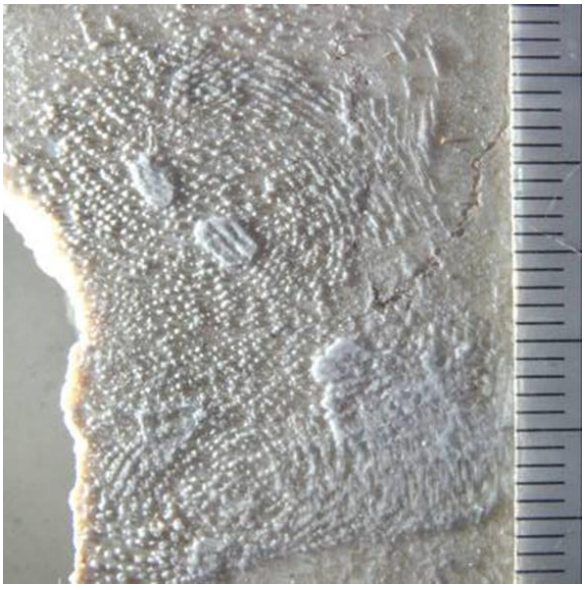

Fig 3. The image of the fingerprint on a marble surface subsequent to cyanoacrylate fuming method application after holding for 3 days

In this study, as a result of various chemical applications in the laboratory on 12 different types of stones, it was revealed that fingerprints with sufficient characteristics could be obtained from various stone types. Fingerprints of good quality were made visible with cyanoacrylate fuming method, particularly on stones with smooth surfaces and minimal porosity such as the outer surfaces of red brick, marble, mosaic, ceramic, tile and granite. However, as the time elapsed between deposition and enhancement increased, the quality of the fingerprints deteriorated and disappeared over time. In addition, cyanoacrylate fuming method was not successful in developing visible fingerprints on stones with very porous structures, such as the inner surfaces of red brick, limestone, andesite, white limestone and paving stone. It was observed that the silver nitrate fingerprint detection method was not effective on any type of stone surfaces. Unexpectedly, fingerprints were made visible on the inner rough surface of the red brick with ninhydrin fingerprint detection method. This result revealed the importance of the method chosen by the fingerprint examiners prior to fingerprint examination on the stones. On the other types of stones, ninhydrin method was also ineffective.

Finally, the success of developing visible fingerprints, and their subsequent quality, from the materials, varied depending on the surface on which the fingerprints are left, along with environmental factors to which the samples were exposed to such as ambient temperature, humidity, dust ratio, etc. In light of the data stated above, all objects which the suspect(s) has become in contact with the surface of should be collected from a crime scene in a proactive manner, and all effort possible should be made to examine them in the laboratory by fingerprint examiners in a timely fashion.

After more than a hundred and thirty years, fingerprints still remain to be considered as one of the most important sources of evidence. It is evaluated that fingerprints developed from stones which have been thrown during an assault could be instrumental in securing of a conviction.

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