Commentary
Volume 10:01, 2025

Journal of Forensic Medicine

ISSN: 2472-1026 **Open Access**

The Effect of UV Radiation on DNA Integrity in Bloodstains Collected from Various Surfaces

Ruggiero Felitti*
Department of Forensic DNA Typing, University of the Punjab, Lahore 53700, Pakistan

Introduction

Deoxyribonucleic Acid (DNA) is the fundamental molecule responsible for storing genetic information within living organisms. Its stability is crucial for various biological processes, including replication, transcription, and repair. However, external factors such as environmental conditions can have detrimental effects on DNA, potentially compromising its integrity. One such factor is Ultraviolet (UV) radiation, a component of natural sunlight that has been extensively studied for its mutagenic and carcinogenic effects. UV radiation, while beneficial in moderate amounts due to its role in vitamin D synthesis, can cause significant damage to biological molecules, particularly DNA. When bloodstains, often used in forensic investigations to establish connections between suspects, victims, and crime scenes, are exposed to UV radiation, the integrity of the DNA within these bloodstains may be compromised. This degradation can affect the accuracy and reliability of DNA analysis, a critical tool in forensic science [1].

The DNA molecule consists of two long chains of nucleotides twisted into a double helix. Each nucleotide is made up of a sugar molecule, a phosphate group, and a nitrogenous base (adenine, thymine, cytosine, or guanine). UV radiation, particularly UV-B, can cause direct damage to DNA by inducing the formation of covalent bonds between adjacent pyrimidine bases (thymine and cytosine), resulting in the formation of pyrimidine dimers. These dimers distort the DNA helix, hindering the DNA replication process and triggering various repair mechanisms in the cell [2].

Description

Bloodstains are among the most critical types of biological evidence in forensic investigations. DNA profiling from bloodstains can provide crucial information, such as identifying suspects, linking them to crime scenes, or determining relationships between individuals. However, the reliability of DNA analysis is contingent upon the preservation of DNA integrity. Factors such as temperature, humidity, surface type, and exposure to environmental conditions, including UV radiation, can influence the quality of DNA extracted from bloodstains. The surface on which a bloodstain is deposited can influence how the blood reacts to environmental conditions, including UV radiation. Wood, paper, and fabric are examples of porous surfaces that can absorb blood. The porous nature of these surfaces can help preserve DNA to some extent by shielding the bloodstain from environmental elements. However, they may also trap moisture, leading to bacterial growth, which can degrade DNA. Glass, metal, and plastic are examples of non-porous surfaces. These surfaces do not absorb blood, and blood tends to dry quickly on them. However, exposure to UV radiation can have a more pronounced effect on bloodstains on non-porous surfaces due to the lack of absorption or shielding, which can lead to increased degradation of the DNA [3].

UV radiation, particularly UV-B and UV-C rays, can lead to the degradation of DNA present in bloodstains. Studies have shown that bloodstains exposed to UV radiation for extended periods exhibit a decrease in DNA yield and quality. This is due to the formation of pyrimidine dimers and other forms of DNA damage caused by UV exposure. The longer the bloodstain is exposed to UV radiation, the more significant the damage to the DNA. For instance, bloodstains exposed to UV radiation for hours or days may show complete degradation of the DNA, making it impossible to extract viable genetic material. Shorter exposure periods may result in partial degradation, where the DNA can still be analyzed but with reduced accuracy. Bloodstains on non-porous surfaces, such as glass or metal, tend to degrade more quickly when exposed to UV radiation due to their inability to shield the bloodstains from UV exposure. In contrast, porous surfaces such as wood or fabric may offer some protection by absorbing the blood and potentially reducing the exposure to UV rays. However, this does not eliminate the risk of DNA degradation. The ambient temperature, humidity, and intensity of UV radiation can also influence DNA degradation in bloodstains. High temperatures and low humidity levels can exacerbate the effects of UV radiation, accelerating the breakdown of DNA. Additionally, the angle of UV exposure and the presence of reflective surfaces can alter the extent of DNA degradation [4].

The degradation of DNA due to UV radiation has direct implications for forensic DNA analysis. When DNA is damaged by UV radiation, it becomes fragmented and less likely to yield usable genetic material. The presence of pyrimidine dimers and other DNA lesions can hinder the polymerase chain reaction (PCR), a critical method for amplifying DNA for analysis. As a result, forensic investigators may face difficulties in obtaining high-quality DNA profiles from bloodstains exposed to UV radiation. This can lead to inconclusive or ambiguous results, potentially hindering criminal investigations. In some cases, forensic experts may need to rely on alternative methods of DNA analysis, such as mitochondrial DNA testing or the use of short tandem repeat (STR) markers, which may still provide valuable information even when the DNA is degraded [5].

Conclusion

The effect of UV radiation on DNA integrity in bloodstains is a critical consideration for forensic science, particularly in crime scene investigations where blood evidence plays a vital role. UV radiation, especially UV-B and UV-C, can cause significant damage to DNA, leading to the formation of pyrimidine dimers and other lesions that compromise the accuracy and reliability of DNA profiling. The extent of DNA degradation depends on several factors, including the duration of UV exposure, the type of surface the bloodstain is deposited on, and environmental conditions such as temperature and humidity. Bloodstains on non-porous surfaces are more susceptible to UV-induced DNA degradation, while porous surfaces may offer some degree of protection, though not completely eliminating the risk. To mitigate the effects of UV radiation on DNA integrity, forensic investigators must take precautions when collecting and preserving bloodstains. This includes minimizing exposure to sunlight or artificial UV sources, using appropriate packaging and storage techniques, and conducting DNA analysis as soon as possible to prevent degradation.

Acknowledgement

We thank the anonymous reviewers for their constructive criticisms of the manuscript.

***Address for Correspondence:** Ruggiero Felitti, Department of Forensic DNA Typing, University of the Punjab, Lahore 53700, Pakistan; E-mail: ruggieroelitti@ero.pk*

Received: 02 January, 2025, Manuscript No. JFM-25-162885; **Editor assigned:** 04 January, 2025, PreQC No. P-162885; **Reviewed:** 18 January, 2025, QC No Q-162885; **Revised:** 23 January, 2025, Manuscript No. R-162885; **Published:** 30 January, 2025, DOI: 10.37421/2472-1026.2025.10.395

Conflict of Interest

The author declares there is no conflict of interest associated with this manuscript.

References

1. Sutlović, Davorka, Definis Gojanović, Šimun Anđelinović and Dijana Gugić, et al. "Taq polymerase reverses inhibition of quantitative real time polymerase chain reaction by humic acid." *Croat Med J* 46 (2005).
2. Sutlovic, Davorka, Stjepan Gamulin, Marija Definis-Gojanovic and Dijana Gugic, et al. "Interaction of humic acids with human DNA: Proposed mechanisms and kinetics." *Electrophoresis* 29 (2008): 1467-1472.
3. Zhou, Jizhong, Mary Ann Bruns and James M. Tiedje. "DNA recovery from soils of diverse composition." *Appl Environ Microbiol* 62 (1996): 316-322.
4. Tebbe, Christoph C. and Wilfried Vahjen. "Interference of humic acids and DNA extracted directly from soil in detection and transformation of recombinant DNA from bacteria and a yeast." *Appl Environ Microbiol* 59 (1993): 2657-2665.
5. Tsai, Yu-Li and BH195770 Olson. "Rapid method for separation of bacterial DNA from humic substances in sediments for polymerase chain reaction." *Appl Environ Microbiol* 58 (1992): 2292-2295.

How to cite this article: Felitti, Ruggiero. "The Effect of UV Radiation on DNA Integrity in Bloodstains Collected from Various Surfaces." *J Forensic Med* 10 (2025): 395.