Investigating the Correlation Between Textile Materials and Environmental Conditions on DNA Degradation in Bloodstains

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Introduction

Use of DNA in Forensic Science
DNA plays a critical role in forensic science, and its degradation can significantly impact the integrity of forensic samples, potentially compromising the accuracy of the results (2). By understanding the limitations of DNA, forensic scientists can understand the limitations of their own analysis.

Purpose of the Investigation
Despite advancements in forensic techniques, research on how textile fabrics and environmental conditions interact remains limited. This study aims to determine how different environmental conditions affect various textile fabrics, which can influence DNA quality and degradation differently.

The Investigation
Pig blood samples will be placed on faux leather, wool, polyester, and cotton, then left under various environmental conditions for a set time to simulate real-world forensic scenarios. DNA will be extracted using the phenol-chloroform method, and its quality will be analyzed with a NanoDrop, PCR, and agarose gel electrophoresis,

Hypothesis
Different textile materials and environmental conditions will significantly affect the rate of DNA degradation in bloodstains with natural fibers exhibiting higher degradation rates under harsher environmental conditions compared to synthetic fibers.

Background

DNA degradation is influenced by various environmental conditions:

- **Exposure to Sunlight:** UVB and UVA radiation, leads to DNA damage by causing strand breaks and base modifications (3).
- **High Temperatures:** Result in severe loss of both DNA quantity and quality (1).
- **Humidity:** Accelerates microbial activity, further degrading DNA.
- **Non-Porous Surfaces:** Preserve DNA better over a period.
- **Porous Surfaces:** Lead to faster deterioration of DNA.
- **Time**: There is significant DNA loss within the first 7 days of environmental exposure, with continued decline over time (4).

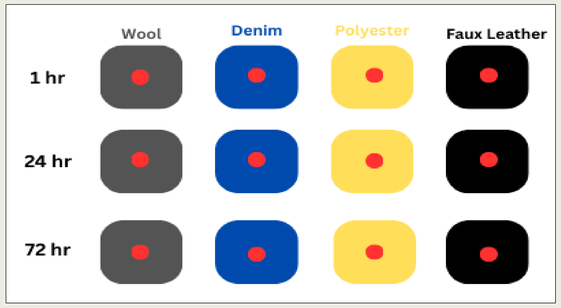
Methodology

1. Experimental Design

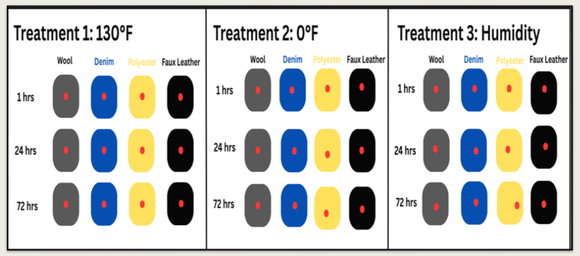
Required Material
35 mL of pig blood
15, 3.5 x 5-inch square wool, denim, polyester, and faux leather fabric

Phase 1: Control Group
Place 500 µL of mice blood in three sterile petri dishes, each incubated at room temperature for 1, 24, and 72 hours. After incubation, DNA will be extracted. This will be repeated for 3 trials.

Phase 2: Textile
500 µL of pig blood will be applied to 12 fabric samples (faux leather, wool, cotton, polyester) with 3 samples per material for incubation times of 1, 24, and 72 hours. After incubation, DNA will be extracted.



Phase 3: Environment
500 µL of pig blood will be applied to 32 fabric squares and subjected to three different environmental conditions: 130°F, 0°F, and constant humidity. Each condition will have incubation times of 1, 24, and 72 hours. After incubation, DNA will be extracted.



2. Extraction of DNA

Preparation of the Sample
~1 cm² square of blood-stained fabric will be cut and placed in a microcentrifuge tube.

Phenol-chloroform extraction method
1. Cell Lysis
2. Phenol Extraction
3. Chloroform Extraction
4. DNA Precipitation
5. DNA Pelleting and Washing
6. DNA Resuspension

3. Examination of the Samples

- **NanoDrop:** a spectrophotometer used to measure the concentration and purity of nucleic acids .

Determination of quality: Good quality. Pure DNA has an A260/A280 ratio around 1.8 and an A260/A230 ratio between 2.0–2.2.

- **Agarose Gel Electrophoresis:** A technique used to separate, visualize, and analyze DNA, RNA, or proteins based on their size.

Determined quality: Good quality DNA appears as a sharp, bright band near the top of the gel with little to no smearing, indicating intact DNA. Poor quality DNA shows as a smeared pattern down the lane, which indicates degradation.

Expected Results

The level of degradation in the DNA extracted from the blood stains will increase as the treatments become more intense. As time increases, the level of degradation will also rise because the samples are exposed to their environment for a longer period. As degradation increases, the quality of the DNA will decrease, along with the quantity extracted. As stated in the hypothesis the rate of DNA degradation is expected to be higher on natural fibers compared to synthetic fibers.

Conclusion

DNA is a key factor in forensic science investigations, and understanding its complexities can assist forensic scientists in their work. The degradation of DNA over time, in harsh environments, and on different textile fabrics has been studied individually. However, how these factors overlap and influence one another has not been thoroughly explored. This study aims to fill that gap, providing insights that could improve the reliability of DNA evidence recovered from crime scenes.

Literature Used

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