H75 Bleach Decontamination in the Forensic Laboratory and at the Crime Scene: Investigating the Efficacy of DNA Damage in Native Versus Naked Templates

Alyssa N. Tuccinardi, Stamford, CT 06902; Angie Ambers, PhD, University of New Haven, Forensic Science Department, West Haven, CT 06516*

Learning Overview: The goal of this presentation is to educate attendees about differences in the efficacy of bleach in generating damage to native and naked DNA templates.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating that amplifiable DNA can often still be recovered from human blood that has been exposed to bleach, especially if the DNA is still encompassed in its native tissue upon initial exposure.

In forensic casework, there are three major factors that significantly impact successful recovery of a DNA profile from evidence, including low-quality (degraded) DNA, low-quantity DNA, and the presence of endogenous or environmental inhibitors. The latter two factors have largely been mitigated by recent advances in instrumentation, "increased sensitivity" methods, and improvements in DNA extraction techniques. However, DNA damage/degradation is inherent in an evidentiary sample when it arrives in the laboratory. The degree and spectrum of DNA damage present depends on the environment to which it was exposed and the length of exposure time. In the natural environment, ultraviolet light, acidity, heat, and humidity all contribute to various forms of damage in the molecular structure of DNA. In addition to environmental insult, chemicals can be used to damage DNA. Bleach is used intentionally by criminals to clean up crime scenes and destroy DNA evidence.

Bleach (sodium hypochlorite [NaOCl]) degrades DNA through oxidative damage and production of chlorinated base products. Knowledge of this damaging effect of bleach on DNA is the basis for its use in forensic laboratories to clean workbenches and prevent cross-contamination of samples between cases. Although decontamination procedures in a forensic laboratory setting are carried out with dilute (10%) bleach, criminals are likely to use much higher concentrations (100%) in attempts to destroy DNA evidence. A previous study demonstrated that bleach has a decreased effect on native DNA that is still encompassed within a body fluid (compared to naked DNA that has already been extracted).[1] Completion of the clotting mechanism appeared to interfere with bleach's ability to cause substantial DNA damage. This decreased effect of bleach on native templates may be explained in part by understanding the physical packaging of DNA, as it exists within human cells or body fluids. Nuclear DNA is not a "naked" molecule. In its native conformation, DNA is a supercoiled structure that is highly packaged into chromatin and is associated with a variety of other molecules, such as histone proteins, residual proteins, phosphoproteins, RNA species, and lipids. Hence, the manner or degree in which damage occurs to DNA in its native complexed form is likely quite different than in its "naked" counterpart. Native DNA may be afforded some protection from damage because it is surrounded by a cellular milieu of proteins, lipids, carbohydrates, and other nucleic acids (RNA).

This research expanded on a previous study, with an increased sample size and expanded data set. Whole human blood (native DNA) and extracted (naked) DNA were immersed in 10% and 100% bleach solutions for one hour. Ten times the volume of bleach was used for the damaging experiments on whole blood or naked DNA, respectively (10:1 bleach:blood/DNA). DNA extractions were performed with the QIAamp® DNA Investigator Kit; recovered DNA was quantified using the Quantifier™ Human DNA quantification kit and a 7500 Real-time Polymerase Chain Reaction (PCR) system. Results were consistent with the previous study. Sufficient DNA was recovered for Short Tandem Repeat (STR) typing, for both native and naked DNA templates and after exposure to both 10% and 100% bleach solutions (with higher DNA recovery from native templates and the lower percentage bleach concentration). These findings have value because they indicate that current decontamination methods using bleach in the laboratory may not be as effective as perceived (at least for DNA complexed with other materials). Decontamination of laboratory workbenches may actually partially be due to physical removal of DNA from a surface ("wiping away") as opposed to solely chemical destruction. Additionally, it is often assumed that if a criminal has cleaned a crime scene with bleach, any underlying DNA evidence has been destroyed (which may prevent investigators from swabbing the area and submitting samples to laboratories for DNA analysis). This study demonstrates that evidentiary items presumably exposed to bleach still should be collected and submitted for DNA testing.

Reference(s):

1. Ambers, Angie, Meredith Turnbough, Robert Benjamin, Jonathan King, and Bruce Budowle. (2014) Assessment of the role of DNA repair in damaged forensic samples. *International Journal of Legal Medicine* 128(6): 913-921. doi:10.1007/s00414-014-1003-3.

Degraded DNA, Oxidative Damage, Bleach Decontamination

*Presenting Author