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Strategies for DNA Analysis from Contaminated Forensic Samples

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Crime scene management and the analysis of forensic evidence get significantly more complex if radioactive contamination is present. For analysis of classical forensic evidence, different strategies can be chosen such as establishment of a forensic laboratory which is licensed and equipped to handle radioactive materials or decontamination of evidence for subsequent analysis in a classical forensic laboratory.

In this work, the capability of a standard forensic DNA purification kit (Charge Switch Forensic DNA Purification Kit, Invitrogen, USA) to decontaminate DNA samples from radionuclides typical for nuclear security scenarios (e.g. 90Sr, 137Cs, 192Ir, 241Am, 232Th, Pu, U) was investigated with the aim to achieve sufficient decontamination for further processing the purified DNA sample in a standard forensic laboratory. A practical challenge for releasing the purified samples to a forensic laboratory is to prove the absence of contamination in a small amount of DNA eluate after separation with the purification kit. The legal limits for the unconditional release of radioactively contaminated items after decontamination may differ from country to country. We used the limits defined in the German Radiation Protection Act (Strahlenschutzverordnung) as guidance for our investigations. In our investigations we established the decontamination factors for the above mentioned radionuclides and could show that the radionuclides mostly remain in the solvents during processing. In consequence, the separated DNA contains only negligible amounts of the initial activity.

In many cases a direct radioactivity measurement of the DNA eluate sample would not be feasible as the required detection limits are difficult to achieve or destructive methods such as LSC would be necessary. To provide a method for indirect assessment of the DNA eluate, the radionuclide concentrations in the different solutions during lysis, washing and elution steps with the DNA purification kit were determined and decontamination factors were established. It could be shown that measurement of the radionuclide in the initial lysis solution in combination with the decontamination factor for the investigated radionuclide allows to demonstrate compliance with the necessary release limits for the purified DNA samples. Thus, we propose a strategy for analysing DNA samples that are contaminated with radioisotopes that involves the extraction and separation of DNA using the well-established Charge Switch method in a nuclear laboratory and then transfer the DNA to a classical forensic laboratory for further treatment.

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