ABSTRACT

The ultimate goal of trace forensic evidence in a criminal investigation is to identify the people, places and things involved in the commission of the crime. The reality is that, with most types of non-biological trace evidence, association (however strong) rather than positive identification is a more likely outcome. A commonly found trace material that does not appear to be widely analyzed in operational crime labs at this time is household dust. This is unfortunate since the potential for identification rather than merely association with this type of evidence is a realistic possibility. Dust bunnies appear to be a unique entangled conglomerations of fibers containing a variety of inorganic and organic particulates from the immediate environment that are formed over a period of time due to air flow and that accumulate inside rooms (inside homes or the workplace), vehicles (e.g. truck) or even in some outdoor locations. They can be transferred onto, for example, the clothing of a body that has been dragged across the floor prior to the body being taken away and deposited elsewhere. Thus, in principle, if one or more dust bunnies are found associated with a crime it should be possible to positively identify the room from which it originated. However, the presence of the dust bunny would be enhanced not only if the dust bunny could be identified also the habitual occupant of the room. This might be accomplished by sensitive DNA typing of the cellular material that is trapped inside the dust bunny (likely originating from the habitual occupant of the room). Therefore, in the current work we seek to develop a methodological and genetic analysis of household dust.

We genetically profiled dust bunny samples using varying approach and amplify DNA from whole dust bunny samples with standard and increased cycle number STR profiling and 2) “non-target” analysis of the dust bunny sample contents from inorganic and organic bio-particles present in the dust bunny samples using micro-manipulation and enhanced micro-volume direct PCR STR profiling.

With demonstrating successful detection and STR profiling of human DNA in dust bunny samples, we are continuing our analysis with a concomitant microscopical characterization of organic and inorganic material from household dust to uniquely characterize the room of origin and its occupants.

METHODS

Whole dust bunnies:
Whole dust bunnies were extracted using a manual organic extraction (Biochrom micro-evolution extraction). Human DNA isolation with the Quantifiler® Human DNA quantification kit (Life Technologies). Amplification of (12 STR) was performed on non-target extracts and the DNA was purified with the MinElute (QIAGEN) purification was performed on any DNA (phenol/chloroform/isoamyl alcohol and ethanol wash, precipitation, and drying). Whole dust bunnies were extracted using a manual organic extraction and a 25 μl total lysis buffer. Lysis buffer is described as “OG buffer (6.7 μl 3 mg/ml 2-chloroethyl glycerol (ECG), 0.1 mg/ml 1.7 M sucrose, 1.0 mg/ml 1.7 M mercaptoethanol (ME), 0.1 mg/ml 1.7 M EDTA, 0.5 mg/ml 1.7 M HEPES, 3.0 M NaCl, 34 μg/ml 1.7 M heparin) added to each sample (25 μl total).”

Micro-Manipulation/Micro-Volume PCR:
Dust bunnies (Dust Bunny, W. Ploschke, J. 12 STR) were fragmented using a Veritol lysis buffer. The dust bunnies were fragmented with a Veritol lysis buffer and a 12 STR STR multiplex was performed. 29 and 34 cycles were performed using the Quantifiler® Human DNA quantification kit (Life Technologies). Amplification of (12 STR) was performed on non-target extracts and the DNA was purified with the MinElute (QIAGEN) purification was performed on any DNA (phenol/chloroform/isoamyl alcohol and ethanol wash, precipitation, and drying).

ENHANCED ANALYSIS: MICRO-MANIPULATION/MICRO-VOLUME PCR

Enhanced analysis performed on 11 dust bunny samples. Bio-particles from 12 dust bunnies (above) were collected using micro-manipulation and analysis using the 12 STR micro-volume one-step PCR STR profiling.

CONCLUSIONS

We have successfully demonstrated that household dust bunnies contain sufficient quantity of human DNA that can be recovered from dust bunny samples.

Data sheet used to characterize, catalogue and identify trace materials found in dust bunnies. Micro-chemical analysis can then be combined with DNA typing.

ACKNOWLEDGMENTS

The authors would like to acknowledge all of the anonymous donors who provided samples for this study. This work was supported by Award No. 2013-ST-EX-K025, awarded by the National Institute of Justice, Office of Justice Programs, U.S. Department of Justice. The opinions, findings and conclusions or recommendations expressed in this publication are those of the authors and do not necessarily reflect those of the Department of Justice.