Forensic Science International: Genetics Supplement Series 8 (2022) 3–4

Contents lists available at ScienceDirect

Forensic Science International: Genetics Supplement Series

journal homepage: www.elsevier.com/locate/fsigss

DNA on drugs

Amy Griffin [a,*], Paul Kirkbride [a], Julianne Henry [a,b], Ben Painter [b], Adrian Linacre [a]

[a] Flinders University, Sturt Road, Bedford Park, SA 5042, Australia
[b] Forensic Science SA, GPO Box 2790, Adelaide, SA 5001, Australia

ARTICLE INFO

Keywords:
Illicit drugs
Trace DNA
DNA transfer
Capsules
Tablets
Ecstasy
Drug profiling

ABSTRACT

The use of illicit drugs is a continuing blight on society. Detecting DNA from individuals involved in the manufacturing and distribution of drugs can provide valuable investigative information or strategic intelligence which, in turn, can be used to disrupt the supply and distribution of illicit drugs. Our study details the transfer, persistence, prevalence, and recovery of human DNA on the exterior of tablets and capsules, as well as within drug powders. Various experiments were conducted to mimic stages in the creation and packaging of tablets and capsules. We showed that the act of brief contact (1–3 s) is sufficient to generate informative DNA profiles that can be uploaded and compared to databases internationally. This work complements chemical drug profiling data by linking seizures to each other and individuals via DNA profiles, providing information to prosecution or intelligence agencies. The generation of DNA information from illicit drug preparations is another tool that can be used in the fight against illicit drug manufacture and distribution.

1. Introduction

The use of illicit drugs causes negative impacts on society internationally. Current methods applied to disrupt the supply and distribution of drugs involves analysing the chemical components of the drug material to produce a chemical profile [1]. Previous literature has reported the application of swabbing the outside of drug bags or packaging for DNA in operational laboratories [2,3], this however, is likely to only detect DNA from those handling the packages further down the drug trafficking chain. This is useful information, however detecting DNA from individuals involved in the manufacturing and distribution of drugs higher up the chain would provide further valuable investigative information or strategic intelligence which, in turn, can be used in conjunction with the chemical profile to disrupt the supply and distribution of illicit drugs. As a result of the lack of anti-contamination precautions taken by clandestine drug laboratory operators, cellular material, dust, and micro-organisms can be integrated into drug material during the manufacture and distribution both within the drug powders and on the surface of capsules or tablets. Individuals involved with the synthetic preparation of drugs such as methamphetamine or MDMA may inadvertently deposit their DNA to the drug material through mechanisms such as talking, breathing, coughing, or sneezing within the vicinity of the drugs. There are various studies indicating that DNA can transfer through the air and land on items [4], therefore direct contact is not necessary for DNA of individuals involved to be detected within the drug material, which is often left on trays to dry during various stages of the drug synthesis. Handling of capsules during their preparation using an encapsulator, and the subsequent counting of capsules or tablets into smaller bags for further distribution may allow trace DNA from the hands to transfer to the exterior of the drugs. It could therefore be beneficial to swab the surface of capsules and tablets, and separately analyse the DNA within the capsule/tablet or loose drug powder. Our study details the transfer, persistence, prevalence, and recovery of human DNA on the exterior of tablets and capsules, as well as within drug powders.

2. Materials and methods

Various experiments were conducted in replicates of ten to simulate stages in the creation and packaging of tablets and capsules. Firstly, an encapsulator device was used by a known donor to simulate loading capsules and transferring them into a zip lock bag (the capsules remained empty in this experiment). Secondly, tablets were prepared with a KBr press (used in chemistry) with a commercial pharmaceutical tablet mixture to simulate the high-throughput tablet presses used in clandestine laboratories where limited handling is involved. The tablets were then handled by a known donor by counting them out into a new zip-lock bag. Thirdly, to simulate where DNA may also be present within

* Corresponding author.
E-mail address: amy.griffin@flinders.edu.au (A. Griffin).

https://doi.org/10.1016/j.fsigss.2022.09.001
Received 19 September 2022; Accepted 19 September 2022
Available online 21 September 2022

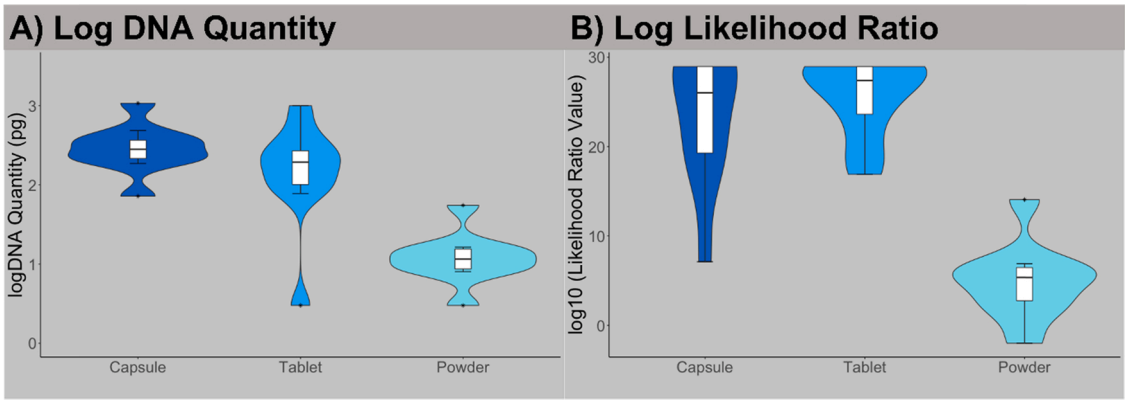

Fig. 1. Violin plots with boxplots overlayed representing A) the log (DNA quantity (pg)) and B) the log (likelihood ratio) of the donor from the swab of the capsule surface, swab of the tablet surface and the entire tablet where DNA was incorporated into the powder prior to pressing. The width of the violins represents the density of samples which fall within that range on the y-axis.

the tablet mixture/drug powder, trace DNA was incorporated into the commercial tablet mixture by asking a donor to wear gloves for four hours, the gloves were then inverted and worn by the researcher who rubbed the powder between the used gloves for approximately ten minutes (this was not to mimic how DNA may be transferred, but to simply add a realistic form of trace, low quality DNA which could be homogenised within the powder). This tablet mixture with DNA incorporated by a known donor was then pressed with the same KBr press used above. The surface of the capsules and tablets were swabbed with Isohelix™ MS-02 buccal swabs (Cell Projects Ltd, Kent, UK) moistened with isopropanol and the tablets with the DNA incorporated within the powder were put directly into a DNA extraction.

The DNA IQ™ (Promega, Wisconsin, USA) was used following the manufacturer's protocol with an initial lysis volume of 400 μL and a final elution volume of 60 μL. The samples were then quantified using Investigator® Quantiplex Pro RGQ (QIAGEN, Victoria, Australia) and STR profiled using VeriFiler™ Plus PCR Amplification Kit (ThermoFisher Scientific, Victoria, Australia) following the manufacturer's protocol. The PCR products were separated on a 3500 Genetic Analyser (ThermoFisher Scientific) with 0.5 μL 600 LIZ® size standard (ThermoFisher Scientific), 8.5 μL Hi-Di formamide, and 1 μL PCR product.

Profiles were analysed on GeneMapper® ID-X (version 1.4) and deconvoluted with STRmix™ (version 2.8.0). Likelihood ratio (LR) values were also calculated using STRmix™. RStudio was used for statistical analysis using Kruskall-Wallis tests with a statistical significance at p-value < 0.05.

3. Results and discussion

We showed that the act of brief contact (1–3 s) is sufficient to generate informative DNA profiles that can be uploaded and compared to databases internationally (Fig. 1). The median DNA yield for the swabs from the surface of the capsules was 285 pg with a subsequent median LR of 4.5×10^{28} for the known donor. The swabs from the surface of the tablets had a median DNA yield of 195 pg and an LR of 2.3×10^{28} for the known donor. The tablets which had DNA integrated into the powder had a median DNA yield of 12 pg and a median LR of 2.6×10^{5} for the known donor.

The powder had a significantly lower DNA yield and subsequent LR value compared to the capsules and tablets (p-value 2×10^{-4}). The tablets and capsules were held directly which could explain the higher deposition of DNA on these substrates compared to the powder. It is difficult to simulate the amount of DNA which may be integrated into drug powders during the synthesis as this would depend on many factors, therefore it is possible that genuine seizure samples may contain more (or less) than what was detected in this study. All profiles were single source except for 20 % of the capsule samples which had two contributors detected. Partial profiles of the known donors were still yielded and could be useful for identification or intelligence purposes.

4. Conclusion

This work complements chemical drug profiling data by linking seizures to each other and individuals via DNA profiles, providing information to prosecution or intelligence agencies. The generation of DNA information from illicit drug preparations is another tool that can be used in the fight against illicit drug manufacture and distribution.

Declaration of Competing Interest

None.

References

[1] M. Collins, Illicit drug profiling: a historical perspective, Drug Test. Anal. 14 (3) (2022) 404–410.
[2] A. Zamir, Y. Cohen, M. Azoury, DNA profiling from heroin street dose packages, J. Forensic Sci. 52 (2) (2007) 389–392.
[3] A.E. Fonneløp, S. Faria, G. Shanthan, P. Gill, Who packed the drugs? application of Bayesian networks to address questions of Dna transfer, persistence, and recovery from plastic bags and tape, Genes 13 (1) (2021) 18.
[4] E.L. Clare, C.K. Economou, C.G. Faulkes, J.D. Gilbert, F. Bennett, R. Drinkwater, J. E. Littlefair, eDNAir: proof of concept that animal DNA can be collected from air sampling, PeerJ 9 (2021), e11030.