TECHNICAL NOTE

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The Effect of 1,2-Indanedione, a Latent Fingerprint Reagent on Subsequent DNA Profiling

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ABSTRACT: The compound 1,2-indanedione was recently introduced in our laboratory as an operational reagent for developing latent fingerprints on porous surfaces. As part of the reagent implementation, a study was carried out in order to determine whether either of the two operational 1,2-indanediones formulations interferes with further DNA profiling. Both formulations are based on HFE7100 solvent. One is acidic and the other neutral. In a controlled experiment, known donors attached stamps to envelopes by licking them. The stamped envelopes were initially treated with either one indanedione formulation or the other, and DNA was then extracted for STR typing. No differences were observed between the STR profiles obtained from treated and untreated stamps and envelopes, indicating that 1,2-indanedione does not adversely affect the extraction and subsequent amplification of the STRs examined. However, preliminary results indicate that potential DNA analysis depends on the time interval between the indanedione treatment and DNA extraction as no DNA can be recovered six days following treatment. For this reason, it is strongly recommended to extract DNA from treated items of evidence as soon as possible after indanedione treatment.

KEYWORDS: forensic science, latent fingerprints, 1,2-indanediones, DNA profiling, short tandem repeat (STR), polymerase chain reaction (PCR), THO1, TPOX, CSF1PO, VWA, FESFPS, F13A, D13S317, D7S820, D16S539, saliva, stamp

Envelope and stamp evidence, commonly encountered in extortion, threats, kidnapping, and mail bomb cases, could provide important information in criminal investigations. These types of evidence samples may require latent fingerprint examinations and DNA analysis of saliva, the two ultimate personal identification methods in forensic science. DNA can be extracted from the epithelial cells present in saliva and, using the current PCR technology, a profile determined (1,2). However, it is important to determine if latent fingerprint processes interfere with subsequent DNA typing. Until recently, envelopes and stamps have routinely been processed in the latent fingerprint development laboratory at the Division of Identification and Forensic Science (DIFS) of the Israel National Police by using a 1,8-diazofluoren-9-one (DFO) - ninhydrin - physical developer sequence (3). Successful typing of DNA after ninhydrin and DFO treatment has been reported (4,5), although the physical developer process has been shown to have controversial degrading effects on DNA recovery (6,7).

The compound 1,2-indanedione was recently introduced as an operational reagent for chemical development of latent fingerprints on porous surfaces such as paper in the latent fingerprint development laboratory. Indanedione reacts with amino acid residues present in fingerprints to produce a fluorescent image (8,9), and can develop more fingerprints than 1,8-diazofluoren-9-one (DFO) on some types of paper (10). As a part of the implementation process, the performance of the two currently used 1,2-indanediones formulations were evaluated and compared. Both are based on HFE7100 as the main carrier (50–70% methyl-nonafluoroisobuthyl-ether and 30–50% methyl-nonafluorobutyl-ether) and contain other co-solvents. One formulation, recommended by the researchers at the Police Scientific Development Branch (PSDB) of the British Home Office (personal communication, SJ Gardner and DF Hewlett, PSDB, Home Office, UK), is an acidic solution (Formulation I), while the second one, proposed by the DIFS and the Hebrew University of Jerusalem (10), is a neutral formulation containing a higher concentration of 1,2-indanedione (Formulation II).

In this study, we examined and compared both formulations for possible interference with subsequent DNA profiling, in cases where the forensic biology laboratory must further examine the same item of evidence. Controlled experiments were carried out on stamped envelopes, which are commonly submitted for fingerprint development, DNA extraction, and subsequent profiling in routine casework.

Materials and Methods

Exhibits

Phase 1—One member of our lab (referred as Donor A) attached five identical stamps (25 mm by 20 mm), by licking once, to white standard envelopes. The same donor also licked two pieces of the same envelope paper (stamp size). After several days, two groups of items, each including an envelope with two stamps adhered to it and a portion of envelope paper, which had previously been licked, was treated with one of the 1,2-indanedione formulations. After indanedione treatment and before DNA extraction, a portion of an envelope with a stamp from each group of items was cut in two and the remaining half was divided in two again. In this way, as seen in Table 1, DNA extraction will be performed on a whole stamp, a half and a quarter of a stamp, and on a piece of licked envelope pa-

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per (stamp size). The aim was to try to evaluate the approximate influence on the detection level of DNA recovery induced by the fingerprint reagents formulations, if these exist. An additional stamp attached to an envelope was not treated with any fingerprint reagent and was processed for DNA extraction. A buccal swab from the donor was collected as a reference for DNA profile comparison. DNA was extracted from the samples 2–24 h after fingerprint treatment.

Phase 2—To confirm our results, six additional stamps, three licked by Donor A and three licked by an additional individual (Donor B), were attached to envelopes. As seen in Table 1, one stamp from each donor was treated with indanedione (Formulation I), one stamp with indanedione (Formulation II), and one more stamp from each donor was not treated with any fingerprint reagent and used as a reference for DNA profile comparison. DNA was extracted from the stamps 24 h after fingerprint treatment.

Phase 3—A possible effect of the time interval between the fingerprint treatment and DNA extraction was investigated. For this purpose, six stamps licked by Donors A, B, and by four additional donors (Donors C, D, E, and F) were treated with indanedione (Formulation II). As seen in Table 1, the stamps were extracted for DNA six days after fingerprint treatment (Donors B, C, D, E, and F) and 28 days (Donor A), respectively.

TABLE 1—*Items subjected to indanedione treatment and subsequent DNA typing in each phase of this study and the time interval between fingerprint treatment and DNA extraction.*

Phase of Study	Donors	Evidence Items	1,2-indanedione Treatments	Time Elapsed
1	A	Stamp on envelope	Not treated	2–24 h
	A	Saliva on envelope	Formulations I, II	
	A	Stamp on envelope	Formulations I, II	
	A	Half stamp on envelope	Formulations I, II	
	A	Quarter stamp on envelope	Formulations I, II	
2	A	Stamp on envelope	Formulations I, II	24 h
	B	Stamp on envelope	Formulations I, II	
3	A	Stamp on envelope	Formulation II	28 days
	B	Stamp on envelope	Formulation II	6 days
	C	Stamp on envelope	Formulation II	6 days
	D	Stamp on envelope	Formulation II	6 days
	E	Stamp on envelope	Formulation II	6 days
	F	Stamp on envelope	Formulation II	6 days

Fingerprint Treatment

Each group of items was treated by dipping in one of the indanedione formulations and air drying. Formulation I is composed of 0.025% 1,2-indanedione dissolved in 90 ml ethyl acetate (analytical grade, Frutarom, Israel), 10 ml acetic acid (glacial, Bio Lab, Israel), and 1000 ml HFE7100 (3M Company). Formulation II is composed of 0.2% 1,2-indanedione dissolved in 90 ml ethyl acetate and 1000 ml of HFE7100. The articles treated with Formulation I were placed in a dry oven at 100°C for 10 min. Those treated with Formulation II were placed in a humidity chamber at a temperature of 100°C with 60% relative humidity for 20 min. Indanedione was synthesized at the Casali Institute of Applied Chemistry of the Hebrew University of Jerusalem, according to the protocol suggested by Cava et al (11).

DNA Extraction and STR Typing

DNA was extracted from the stamps and envelopes and from the buccal swabs using the phenol-chloroform extraction method (12). No attempt was made to separate the stamp from the envelope before the extraction. The extracted DNA was then amplified using the PCR method for the following short tandem repeat (STR) markers: THO1, TPOX, CSF1PO, VWA, FESFPS, F13A, D13S317, D7S820, and D16S539 using the CTT, FFV, and Gene Print Silver III System Kits from Promega (Madison, WI). The products of these amplifications were run on 4% denatured polyacrylamide gels and visualized using silver staining (13).

Results and Discussion

As seen in Table 2, STR profiles were successfully typed from all items processed within 2–24 h after fingerprint development with both indanedione formulations (Phases 1 and 2). DNA was even recovered from half and quarter-sized stamps and could also be typed from the saliva stain on the indanedione processed unstamped envelope, although the stamp's glue is believed to help immobilize the buccal cells on the paper. No differences were observed in the DNA patterns following either of the indanedione formulations treatment. The STR profiles were consistent with those obtained from the donor's reference, at all nine loci. Donors A and B STR profiles from stamps treated with both indanedione formulations and correspondent references are shown in Fig. 1.

TABLE 2—*STR profiles (9 loci) from items treated with indanedione and the control references as detailed in Materials and Methods. Phase 1: indanedione (I and II), DNA extraction after 2–24 hours; phase 2: indanedione (I and II), DNA extraction after 24 hours; phase 3: indanedione (II), DNA extraction after 6–28 days; (. . .) no PCR products.*

Locus/Items	TH01	TPO	CSF1PO	VWA	FESFPS	F13A	D13S317	D7S820	D16S539
Donor A									
Reference	6, 7	8, 11	12, 12	16, 18	10, 12	3.2, 5	11, 11	11, 12	11, 13
Phase 1	6, 7	8, 11	12, 12	16, 18	10, 12	3.2, 5	11, 11	11, 12	11, 13
Phase 2	6, 7	8, 11	12, 12	16, 18	10, 12	3.2, 5	11, 11	11, 12	11, 13
Phase 3	…	…	…	…	…	…	…	…	…
Donor B									
Reference	6, 9.3	8, 8	11, 12	16, 17	10, 12	7, 7	8, 11	8, 8	11, 12
Phase 2	6, 9.3	8, 8	11, 12	16, 17	10, 12	7, 7	8, 11	8, 8	11, 12
Phase 3	…	…	…	…	…	…	…	…	…
Donors C, D, E, F									
Phase 3	…	…	…	…	…	…	…	…	…

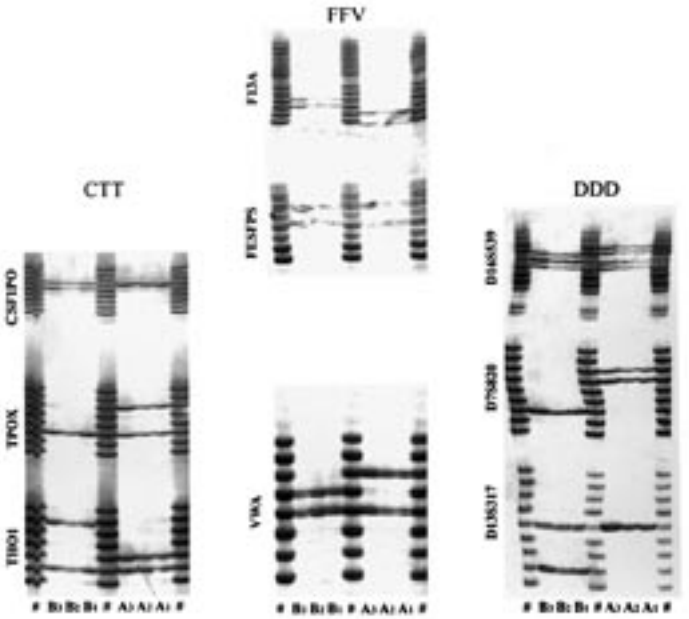

FIG. 1—*STR profiles (CTT, FFV and DDD) obtained from stamps licked by Donors A and B, run on polyacrylamide gels and visualized using silver staining as described in Materials and Methods (Phase 2); (#) allelic ladder; (A1) Donor A, no indanedione treatment; (A2) Donor A, indanedione (I); (A3) Donor A, indanedione (II); (B1) Donor B, no indanedione treatment; (B2) Donor B, indanedione (I); (B3) Donor B, indanedione (II).*(r)

In this case, a weak allele 10 at the TPOX locus can be seen in CTT triplex of Sample B3. This could be a result of a mixture of DNA profiles between Donor B, who licked the stamp, and another individual, who perhaps touched the stamp at an earlier stage.

At Phase 3 of the study, DNA extraction was carried out 6 or 28 days after indanedione treatment. As seen in Table 2, no PCR products could be recovered for any donor. These results indicate that the time interval between the fingerprint treatment and the DNA extraction is critical and seriously affects DNA recovery. Further research is required to investigate the effect of time on DNA degradation following fingerprint treatment. For this purpose, DNA quantitative analysis is required but, unfortunately, this equipment is not available yet in the DIFS.

In conclusion, this simulated experiment demonstrated that DNA could be successfully typed from indanedione treated evidence items. No differences were observed between the STR profiles obtained from indanedione treated articles and reference samples. DNA profiles were recovered even from quarter-sized stamps. However, preliminary results indicate that potential DNA analysis depends on the time interval between indanedione treatment and DNA extraction. For this reason, it is strongly recommended to extract DNA from treated items of evidence as soon as possible after indanedione treatment.

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