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Title: **An Assessment of Tape-lifts**

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Ethics Approval

Prior approval was obtained from the Social and Behavioural Research Ethics Committee (SBREC) at Flinders University (reference 8109).

Conflict of interest

None.

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Highlight

- Fourteen types of tapes were assessed for latent DNA recovery and detection.
- Inhibition, autofluorescence and efficiency of collection was tested.
- Three tapes were suitable for latent DNA collection DD staining and direct PCR.
- Tape-lifting from touched fabrics using three tapes produced full DNA profiles.

Abstract

Tape-lifting is a non-destructive alternative to swabbing for collection of biological materials deposited on surfaces, especially on porous substrates. While there have been a number of studies looking at the efficiency of tapes in terms of recovery and their effect on downstream processes, none has been able to visually monitor cellular material collection.

We report on a comparative study of a range of tapes regarding their collection efficiency of cellular material visualised using fluorescence microscopy, their background fluorescence after staining with DD diluted with three different solvent types and inhibition of subsequent PCR using direct PCR. Three of the fourteen tapes were selected for further testing. These were brown packing tape (Packmate™), clear tape (Sellotape®), and DNA-free tape (Lovell Surgical Solutions). These did not inhibit direct STR amplification; the other eleven tapes exhibited either high background fluorescence and/or inhibition of subsequent PCR. The effectiveness of the three tapes for the collection of cellular material was tested after tape-lifting a fingermark once, twice and ten times. The amount of cellular material within fingermarks stained with Diamond™ dye (DD) was recorded using fluorescence microscopy before and after tape-liftings. The DNA-free tape (Lovell) used in many forensic laboratories gave poor recovery compared to the other two tapes. After a tape-lift, an average of 30% of cellular material was recovered by using DNA-free tape (Lovell), contrasting with an average recovery of 59.5% for the clear tape (Sellotape®) and 88.8% for the brown packing tape (Packmate™). The results presented show that standard crime scene sampling tape does collect DNA but is less effective than shop-bought tapes. Full DNA profiles can be generated from all of touched fabric samples that were collected DNA using the three tapes, triaged by DD staining and amplified by direct PCR approach.

KEYWORDS: Forensic Science; Diamond Dye staining; Direct PCR; DNA collection, Tape-lifts

1. Introduction

DNA is transferred readily onto substrates by a variety of means such as direct contact *via* a hand, secondary transfer and deposition *via* the air through sneezing and talking [1-3]. There are standard processes to collect DNA from items such as double (wet and dry) swabbing [4, 5] and cutting if the item is a fabric [6] or paper [7] then followed by a DNA extraction process. An alternative, non-destructive method used for substrates such as shoe insoles [8], woollen gloves [9] and fabrics [10-12], is tape-lifting.

A number of groups reported on the use of tape-lifts for latent DNA collection and used a variety of tapes intended for forensic and non-forensic use [11-14]. In these studies, the adhesive side of tape was placed on the item/substrate and pressed down so that any material adhering loosely to the substrate was transferred to the tape. The tape, or part thereof, was then subjected to a DNA extraction process or by direct PCR [14-17]. Verdon *et al.* tested the efficiency of two tapes used in their laboratory to collect touch DNA from four different fabrics [12]. In that report, the effect of tape-lifting the same area multiple times was examined along with a comparison of tape-lifting to the double-swab method; it was found that the quantity of extracted DNA and the obtained STR profile from SceneSafe FAST™ mini tape was higher than from Scotch® Magic™ tape. Multiple tape-lifting recovered more DNA than a single tape-lift from the same area, however it was also reported that there was a reduction in the amount of collected DNA when tape-lifting 8 times with Scotch® Magic™ tape and 32 times with SceneSafe FAST™ mini tape. Tape-lifting fabric with either tape resulted in the collection of more DNA than swabbing [12]. These results were inferred based on the quantity of DNA recovered post-extraction process.

The application of Diamond™ nucleic acid dye (DD) has recently been reported for the effective detection of latent DNA on a range of biological materials such as hair roots [18], fingermarks [19-21], enhanced fingermarks [22] and lip-prints [23]. Furthermore, the use of DD to aid visualisation of latent DNA on swabs post-sampling [24] and on improvised explosive devices (IEDs) [25] has been reported. This approach may in the future be an effective triage to determine rapidly whether or not a swab had actually recovered cellular material and therefore whether or not the swab is a candidate for priority processing and DNA profiling. The visualisation of latent DNA therefore has the potential to contribute to the streamlining of forensic laboratory processes and reducing wastage of time and laboratory consumables.

A previous report that included the use of tapes also included the use of fluorescent nucleic acid dyes with *in situ* fluorescence detection to visualise stained buccal cells on a glass slide and tape (standard semi-adhesive tape (Nitto Denko)) before and after tape-lifting [26]. Buccal cells stored in a closed environment for up to 12 months could still be visualised after staining and generated DNA profiles using direct PCR [26]. Krosch M. *et al.* has recently reported the use of DD staining on tapes collected from worn clothes processed following a forensic laboratory procedure [27]. By comparing between ten pairs of DD stained and non-stained fabrics, they reported an inhibitory effect of DD on subsequent DNA amplifications.

A recent proof-of-concept study examined the effective collection and retention of cellular material by a number of tapes using DD followed by direct PCR [28]. Here we report on the assessment of fourteen different types of tapes for their background fluorescence when stained with DD in three different dilution solutions and for any PCR inhibition during direct PCR. This study also describes an effective process to monitor the collection and retention of cellular material on tapes.

2. Materials and methods

2.1 Ethic approval and volunteers

Prior approval was obtained from the Social and Behavioural Research Ethics Committee (SBREC) (reference 8109).

Three volunteers (two females and one male) participated in this study. All volunteers had their shedder status determine prior to any experiments following the established method [19].

2.2 Types of tapes

Fourteen types of tapes used in the study, designated as T01 – T14, included one type used in forensic casework and other types of tape readily available (Fig. S1). There were: T01 - brown packing tape (Scotch®, ADL, Australia); T02 - brown packing tape (Packmate™, ADL, Australia); T03 - clear tape (Scotch®); T04 - clear tape (Sellotape®, ADL, Australia); T05 - clear tape (Nitto Denko™, VIC, Australia); T06 - clear tape (Lovell Surgical Solutions International Pty. Ltd, VIC, Australia); T07 - insulation tape (Click®, ADL, Australia); T08 - gaffer tape (Bear Saint-Gobain Abrasives Pty. Ltd, VIC, Australia); T09 - paper sticker note (purple colour) (Post-it®, ADL, Australia); T10 - plastic sticker note (blue colour) (Post-it®); T11 - plastic sticker note (orange colour) (Post-it®); T12 - plastic sticker note (pink colour)

(Post-it®); T13 - plastic sticker note (yellow colour) (Post-it®); and T14 - plastic sticker note (green colour) (Post-it®).

The external (non-adhesive side) of twelve of tapes were treated to make them DNA-free before use by cleaning with a 3% sodium hypochlorite bleach, wiped with absolute ethanol, and were then irradiating with ultraviolet (UV) light for 15 min. Exceptions were T06 and T09 which were cleaned only on the outside of the package as T06 is a DNA-free tape and T09 is a paper sticky note that would be adversely affected by the bleach solution.

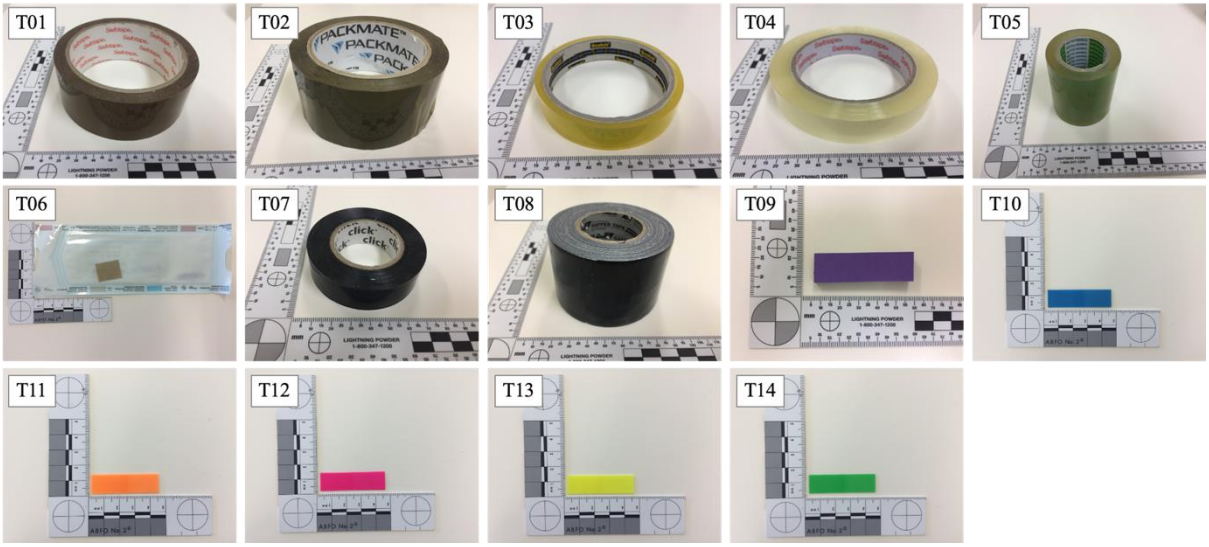

Fig. S1 Showing the fourteen different types of tapes that were included in this study.

2.3 Background fluorescence

Diamond™ nucleic acid dye (Promega, WI, USA) stock solution (10,000x) was diluted (1:500) to 20x working concentration using three types of solvent: 1) sterile water, 2) 75% ethanol in sterile water and 3) 0.01% Triton™ X-100 (Sigma, VIC, AUS) in sterile water. To each tape (with approximate dimensions of 25 mm x 5 mm), 5 µL of 20x DD was applied. The stained tapes were visualised within 1 min and also when the dye solution had dried under a Dino-Lite digital fluorescence microscope (model EDGE AM4115T-GFBW, AnMo Electronics Corporation, New Taipei City, TWN) equipped with a blue LED light source (480 nm) and an emission filter of 510 nm, at 50x and 220x magnifications in ambient light (white LED light in laboratory) and a dark environment (covered with a cardboard box). This study used DinoXcope 2 for MacOS (default setting) as software to operate the microscope and record images. Experiments were performed in triplicate.

2.4 Direct PCR inhibition and STR data analysis

Buccal swabs were collected from a female volunteer who was determined to be a light shedder. DNA was extracted using QIAamp mini DNA kit (QIAGEN, VIC, AUS) and quantified by Qubit® 2.0 Fluorometer (ThermoFisher Scientific, VIC, Australia). Extracted DNA was diluted with DNA-free water to working solution of 1 ng/μL prior to use. Extracted DNA (1 ng) in the absence of any tape was used as a positive control.

Tapes were cut into squares of approximately 5 mm^2 in size. Extracted DNA (1ng) was pipetted directly onto the tapes and placed directly into a PCR tube (BioRad, NSW, AUS). Amplifications were performed in 25 μL using the AmpFLSTR® Identifiler® Plus kit (ThermoFisher Scientific) following the manufacturer's validated protocol of 29 cycles, with the exception of 2 μL of Prep-n-Go™ (ThermoFisher Scientific) that were added into the mixture. PCR product (1 μL) was added to 8.5 μL Hi-Di formamide and 0.5 μL 500 LIZ™, and separated on a 3500 Genetic Analyser (ThermoFisher Scientific). Data were analysed using GeneMapper ID-X (version 1.4) (ThermoFisher Scientific). A peak detection threshold of 50 relative fluorescence unit (RFU) was used for a heterozygote and 150 RFU for a homozygote. All experiments were performed in triplicate.

The average RFU value for all 15 STRs with and without tape was calculated. The RFU of any homozygote was divided in half. If the average RFU for with tapes was higher than without tape, percentage of inhibitory effect was calculated according to the following formula:

$$\text{Percentage of inhibitory} = \frac{(\text{average RFU with no tape} - \text{average RFU with tape})}{\text{average RFU with no tape}} \times 100$$

The inhibitory effect of tapes was calculated by dividing the RFU of the largest allele by the smallest allele (L:S) for each of the four dye channels. The average of ratio for all dye channels of all STR results was then calculated. Data were tested statistically using a t-test (two tails) for two-sample equal variance function in Microsoft Excel.

2.5 Recovery efficiency

A female volunteer, who was determined to be an intermediate shedder, made a fingermark by placing a thumb onto a clean glass slide for 15 s with medium pressure at an undefined time point after handwashing. The deposition of a mark, however, was always made at least 15 min after handwashing.

The marks were stained with 5 μL of 20x DD diluted with 75% ethanol, which was gently spread over the entire mark using a pipette tip. The number of stained cells within a fingermark was recorded based on an average of five frames at 50x magnification before tape-lifting. Tapes were cut into rectangles approximately 25 mm x 5 mm in size prior to tape-lifting. Tape lifts (using the entire 25 mm x 5 mm of tape) were taken from each mark once, twice or ten times, with multiple lifts taken from the same location, and the number of cells remaining on the substrate was recorded after each application. These experiments were performed in five replicates.

The stained cells within these frames were counted by a cell-counting software program developed in-house. All images were analysed using a fixed value of five parameters; 1) hSize = 9, 2) Sigma1 = 1, 3) Sigma2 = 3, 4) RBG filter threshold =10, and 5) Size threshold = 12. The parameters have been validated for counting the number of cells at 50x magnification [29]. Also, all images were double checked manually to ensure the program did not count a false positive result (e.g. detritus and fibres).

2.6 Mock samples on touched fabrics

Fabrics (100% cotton) were cut into squares approximately 50 mm x 50 mm in size and then washed with 3% sodium hypochlorite bleach, allowed to air dry in a clean room, and were then irradiating with ultraviolet (UV) light on both sides each for 15 min. A male volunteer, who was determined to be an intermediate shedder, was asked to handle a piece of fabric for 15 s. This contact was after 30 minutes since the volunteer washed their hands. Contact was made by gently rubbing their thumb and index finger over the fabric. Transferred biological material on the fabrics was collected using one of the tapes with dimension of approximately 25 mm x 5 mm. Tape-liftings were performed on both sides ten times. Tapes were stained with 5 μL of 20x DD diluted with 0.01% Triton™ X-100 and were visualised under the microscope when the dye had dried, following the method described in section 2.3. A 5 mm^2 area of the tape was removed and placed directly into a PCR tube. The samples were processed by the direct PCR and analysed following the method described in section 2.4. All experiments were performed in triplicate.

A buccal swab was collected from the volunteer and a DNA profile generated following the method in described section 2.4 as a reference DNA profile.

3. Results and discussion

3.1 Background fluorescence

Fourteen types of tapes were examined prior to any staining at 50x magnification (Fig. 1). No fluorescence was observed on T01, T02, T03, T04 and T07. Gaffer tape (T08) showed a high background fluorescence due to the uneven substrate. Furthermore, the adhesive side of this type of tape is white in natural light, which contributes additional background fluorescence to the image; this has been described previously with regards to fluorescence imaging of light-coloured surfaces [20, 24]. T05, T06 and T09 showed faint background fluorescence. T09 also exhibited a reddish colour (Fig. 1), which likely came from the red-toned pigment dye used in the manufacture of the purple coloured paper sticky note. Blue plastic sticky notes (T10) also showed faint background fluorescence and cell-like fluorescent dots over the entire tape prior to staining when viewed at both 50x and 220x magnifications (Fig. 1 and Fig. S2). The cell-like dots that exhibited fluorescence were similar in appearance to the cellular material after staining with DD; however, the difference in terms of shape, size and fluorescence intensity could be distinguished as shown in Fig. S1, A. The other four coloured plastic sticky notes (T11- T14) showed extremely high background fluorescence prior to staining (Fig. S2, B), thus they were excluded from this study.

Fig. 1 shows the stained tapes when the DD solution had dried completely. No fluorescence was observed on T02, T04 and T06 after staining the tapes with 20x DD diluted with sterile water, while high background fluorescence was noted on T05, T09 and T10. T01, T03 and T07 showed faint background fluorescence. High background fluorescence was noted on all tapes when the tapes were still wet (except T06 and T07), as seen in Fig. S3.

High background fluorescence was observed when all tapes (except T06 and T07) were stained with 20x DD diluted with 75% EtOH, both immediately after staining (Fig. S3) and when the solution was dried (Fig. 1).

After staining the tapes with 20x DD diluted with 0.01% Triton™ X-100, no background fluorescence was noted from five types (T01, T02, T04, T06 and T07), both immediately after staining (Fig. S3) and when the solution was dried (Fig. 1). T03 showed faint background fluorescence, the same as when stained with DD diluted with sterile water. High background fluorescence was noted on T05, T09 and T10.

(suggested Fig. 1)

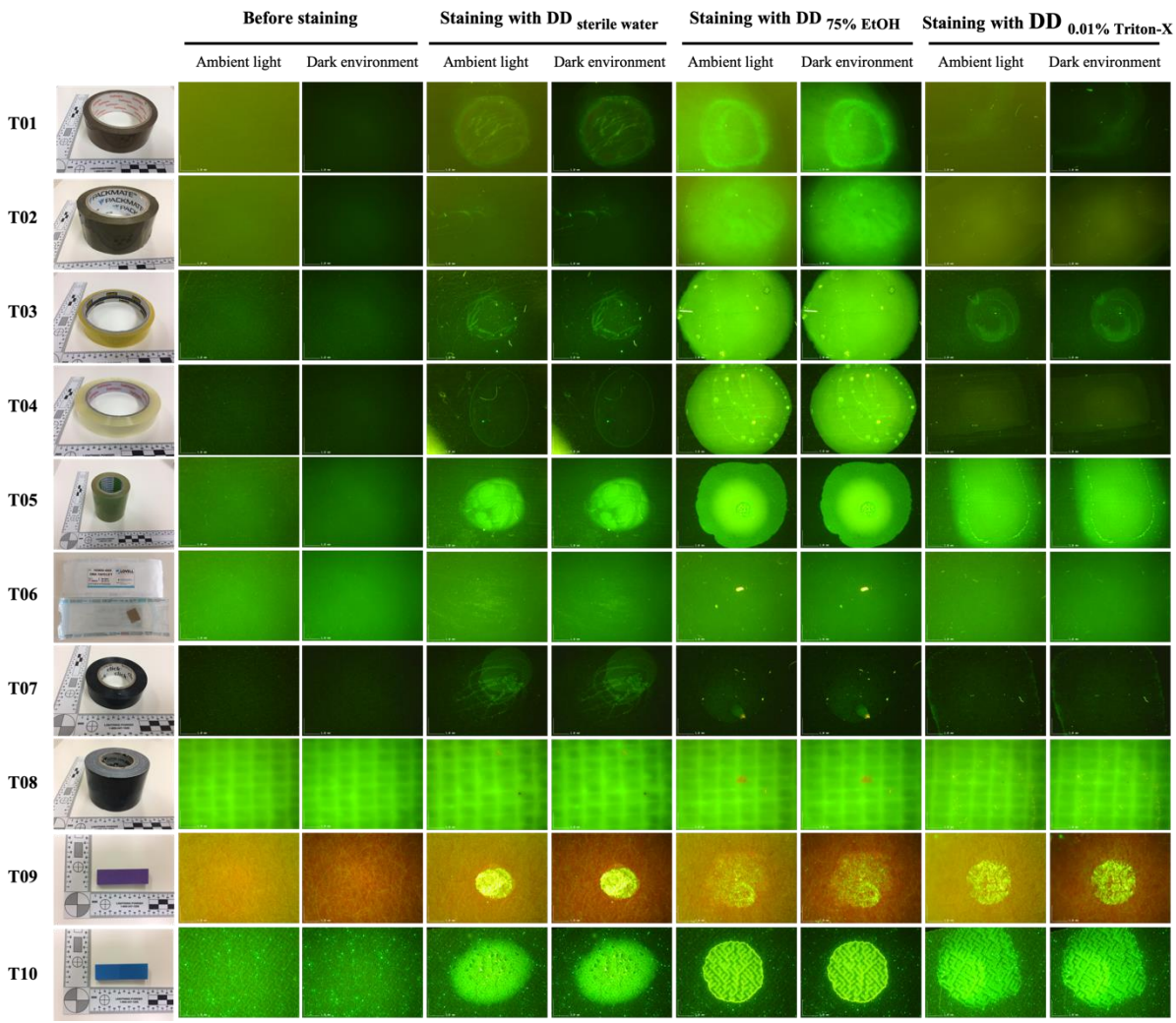

Fig. 1. Showing background fluorescence of all ten types of tapes (T01-T10) before and after DD staining when the solution had dried. DD was diluted with three different types of solvent: water, 75% ethanol and 0.01% Triton™ X-100, to 20x DD working concentration. Tapes were visualised at 50x magnification in both ambient light and a dark environment.

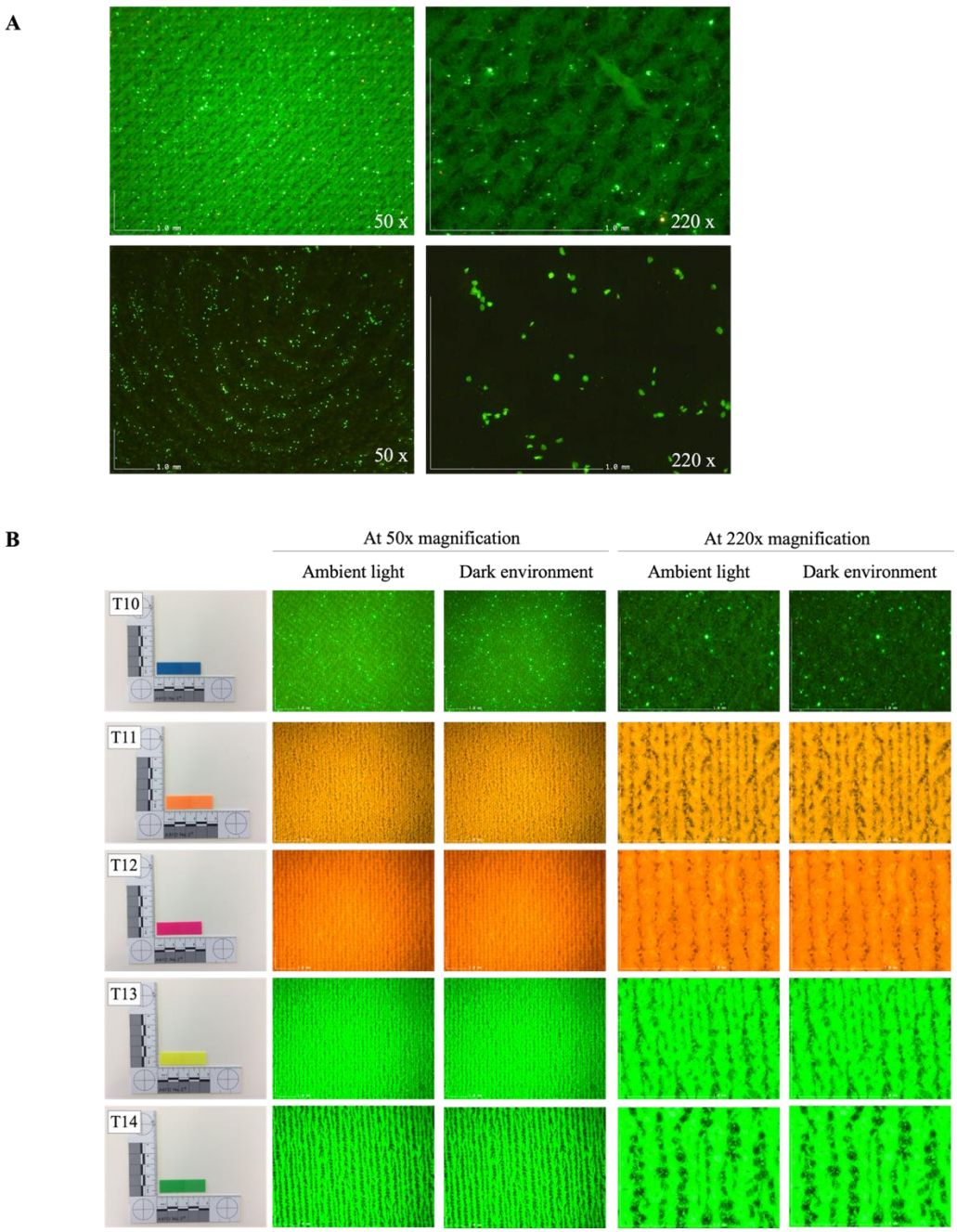

Fig. S2 Showing plastic sticky note (T10-T14) at the adhesive part without DD staining at 50x and 220x magnifications. Panel A shows the comparison between auto-fluorescence on the blue sticky note (T10, top row) and DD stained fingermark on glass slide (bottom row) at 50x and 220x magnifications. Panel B shows the five different colours of plastic sticky notes: blue (T10), orange (T11), pink (T12), yellow (T13) and green (T14) without DD staining were visualised in both ambient light and a dark environment.

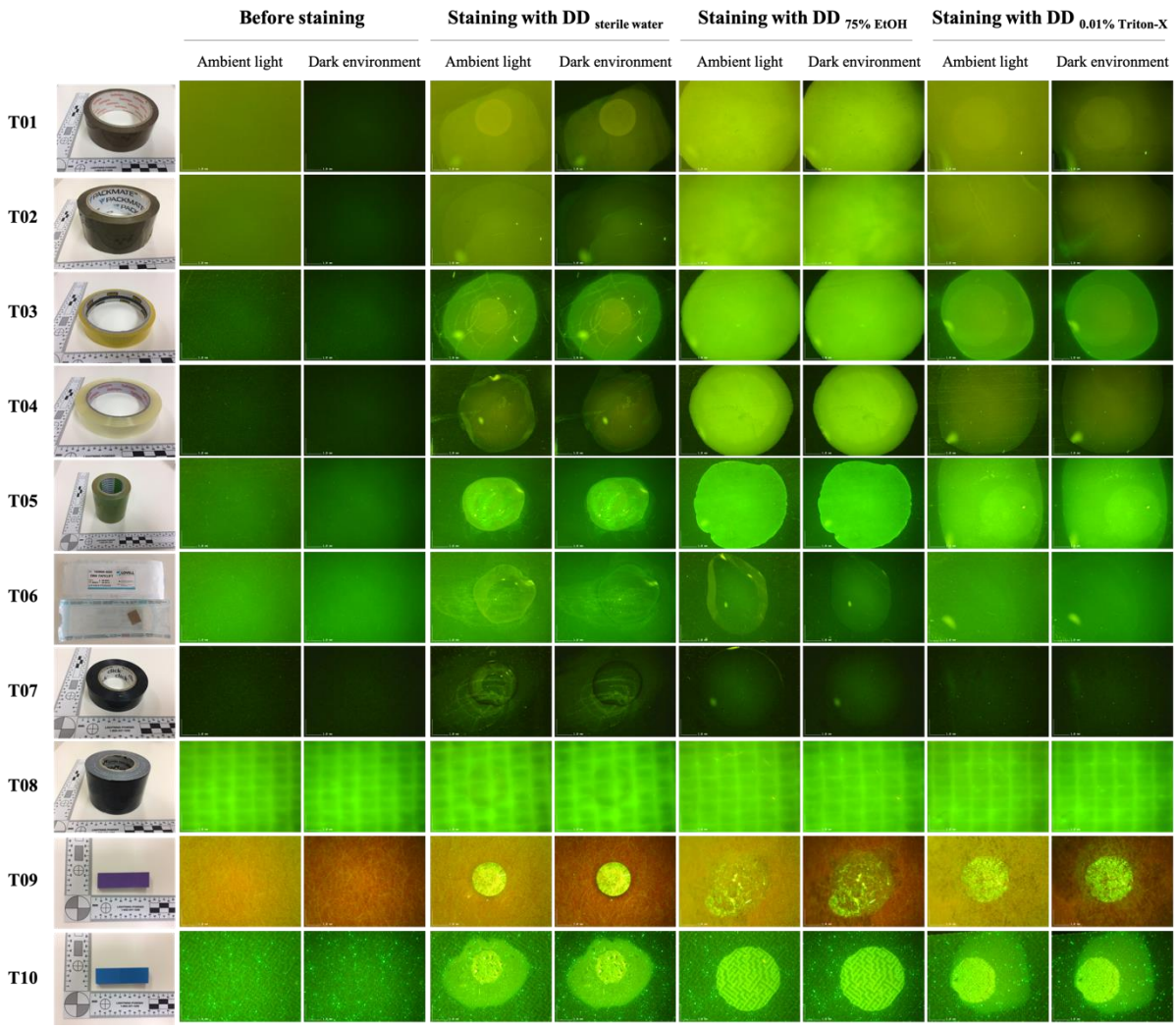

Fig. S3. Showing background fluorescence of all ten types of tapes (T01-T10) before and immediately after DD staining. DD was diluted with three different types of solvent: water, 75% ethanol and 0.01% Triton™ X-100, to 20x DD working concertation. Tapes were visualised at 50x magnification in both ambient light and a dark environment.

3.2 Effect of tape on direct PCR amplification

The average RFU values of the STR results were calculated for each dye channel and in total for all dye channels (Fig. 2A). T02, T04 and T06 did not exhibit inhibition as the average RFUs were comparable to those of the positive control when no tape was added. Low to medium level of inhibition was noted for T03 (8.8%, $p = 0.489$), T05 (25.1%, $p = 0.052$), T07 (24.1%, $p = 0.259$) and T10 (0.4%, $p = 0.963$) compared to the positive control when no tape was added (Fig. 2B). Significant PCR inhibition was observed for T01 (38.2, $p = 0.049$), T08 (54.1%, $p = 0.017$) and T09 (100.0%, $p = 0.000$). T09 did not produce any STR data, possibly due to the PCR solution being entrapped in the paper sticky note, which may affect

the function of the PCR reagents, or the glue or pigment dye used for T09 strongly inhibits PCR amplification.

There was no significant different of the average L:S ratio noted for all tested tapes ($p > 0.05$) compared to the positive control when no tape was added (0.73 average L:S ratio), with the exception of T09 ($p = 0.000$) as seen in Fig. 2C. The RFU data for the smallest and largest alleles for T07 and T08 showed no significant difference (0.51 and 0.43 average L:S ratio, $p = 0.149$ and 0.115, respectively). Fig. S4 shows representative STR profiles when using tapes with no inhibitory affect (T02, T04 and T06) and tapes where inhibition was noted (T07 and T08).

The inhibitory effect of DD on direct PCR amplification was tested further by directly adding 1 μL of 20x DD diluted with 0.01% Triton™ X-100 in sterile water into the PCR tube (Fig. 2A). The results showed there was no significant difference between the average RFU of the control PCR sample and the PCR adding 1 μL of 20x DD diluted with 0.01% Triton™ X-100 in sterile water (a final DD concentration of 0.8x, $p = 0.75$). No difference between the L:S ratio was noted (0.74 average L:S ratio, $p = 0.87$) when compared with the positive control where no tape was added (0.73 average L:S ratio), as seen in Fig. 2C.

Our data support a previous report examining whether DD diluted with 1x tris-acetate (TA) could be an alternative dye in a real time PCR [30]; this previous study showed that the recommended DD concentration in real-time PCR is 0.5x. The report also showed that 0.1x, 0.5x, 1x and 1.5x DD final concentrations do not inhibit qPCR amplification, however PCR inhibition was indicated when the final concentration of DD is higher than 2.0x [30]. This is in contrast with a recent study that showed 0.24x and 0.48x DD diluted with DNA-free deionized water inhibited direct PCR by weak and moderate levels respectively [25].

Low concentrations of Triton™ X-100 (0.1% in sterile water) have been used for moistening swabs in previous studies; no indication of direct PCR inhibition was recorded [17, 31-33]. DD diluted with 0.01% Triton™ X-100 spread easily across tapes, in contrast to when diluted with water, therefore 0.01% Triton™ X-100 is the recommended DD solution to visualise cellular material on tape.

Based on the data examining both background fluorescence and direct PCR inhibition, there was an indication that there were three tapes (T02, T04 and T06) that warranted further testing.

(suggested Fig. 2)

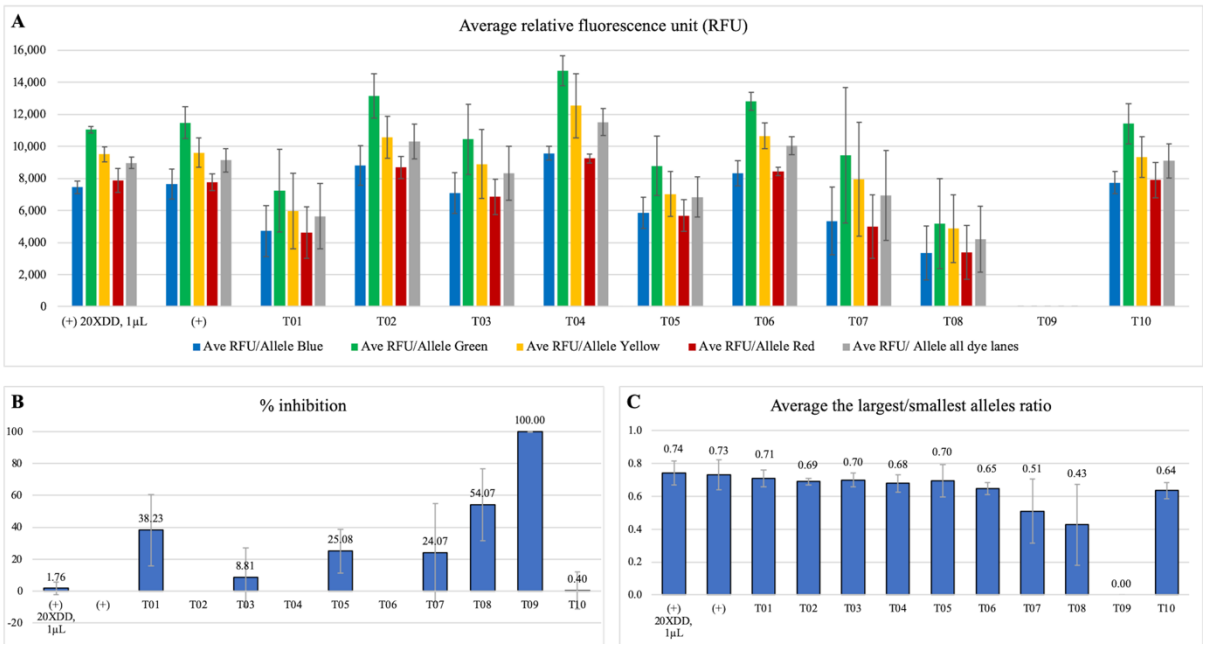

Fig. 2. Showing the effect of ten tapes on direct PCR amplification using the AmpFLSTR® Identifiler® Plus kit (29 cycles). Panel A shows average relative fluorescence unit (RFU) value in each dye channels (blue, green, yellow and red) and all dye channels (grey). Panel B shows the percent of inhibition of ten tapes. Panel C shows the average ratio between RFU of the largest and smallest alleles (L:S), calculated by dividing the RFU of the largest allele by the RFU of the smallest allele of each dye channel. Extracted DNA (1 ng) was used for PCR amplification. All experiments were performed in triplicate.

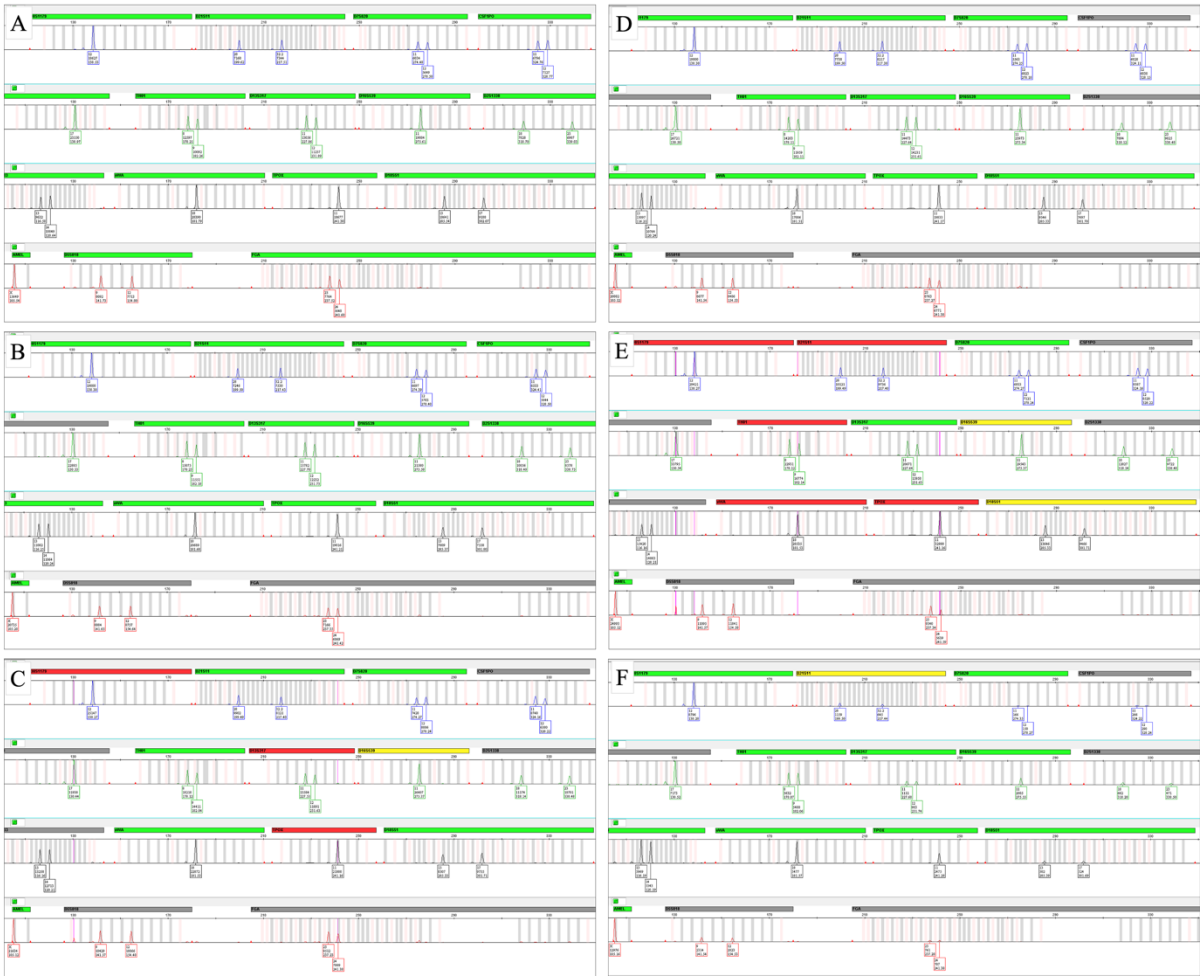

Fig. S4. Showing DNA profiles from STR amplification of 1 ng extracted DNA using the AmpFLSTR® Identifiler® Plus kit (29 cycles) of the positive control when no tape was added (A), and when added approximately 5 mm^2 of T02 (B), T04 (C), T06 (D), T07 (E) and T08 (F). All experiments were performed in triplicate.

3.3 Recovery of cellular material

The cellular material recovered after tape-lifting the same area once, twice, and ten times was based on the percentage of recovery when viewed at five separate frames at 50x magnification. By counting cells remaining on the glass slide (Fig 3B), an extrapolation was made regarding the percentage recovery for each tape (Fig 3A). After only one lift using the brown packing Packmate™ tape (T02) and clear Sellotape® (T04), the percent of cellular material recovery was 88.8% and 59.5% respectively. DNA-free Lovell tape (T06) showed the lowest cellular material recovery of 30% after one lift and even after a second lift showed only 47% (n = 5). After tape-lifting a fingermark 10 times, tapes T02, T04 and T06 showed 98.8%, 90.0% and 78.0 % recovery of cellular material respectively.

Our data supported previous findings that multiple tape-lifting of the same area resulted in a higher DNA yield than only one time tape-lifting [12]. Tape-lifting of a large area using multiple tape-lifting technique can be time consuming and generates multiple strips of tape from an exhibit [34], however this study showed the brown packing tape could be an alternative tape as it has a high efficiency of collection (88.8%) after only a single tape-lifting.

(suggested Fig. 3)

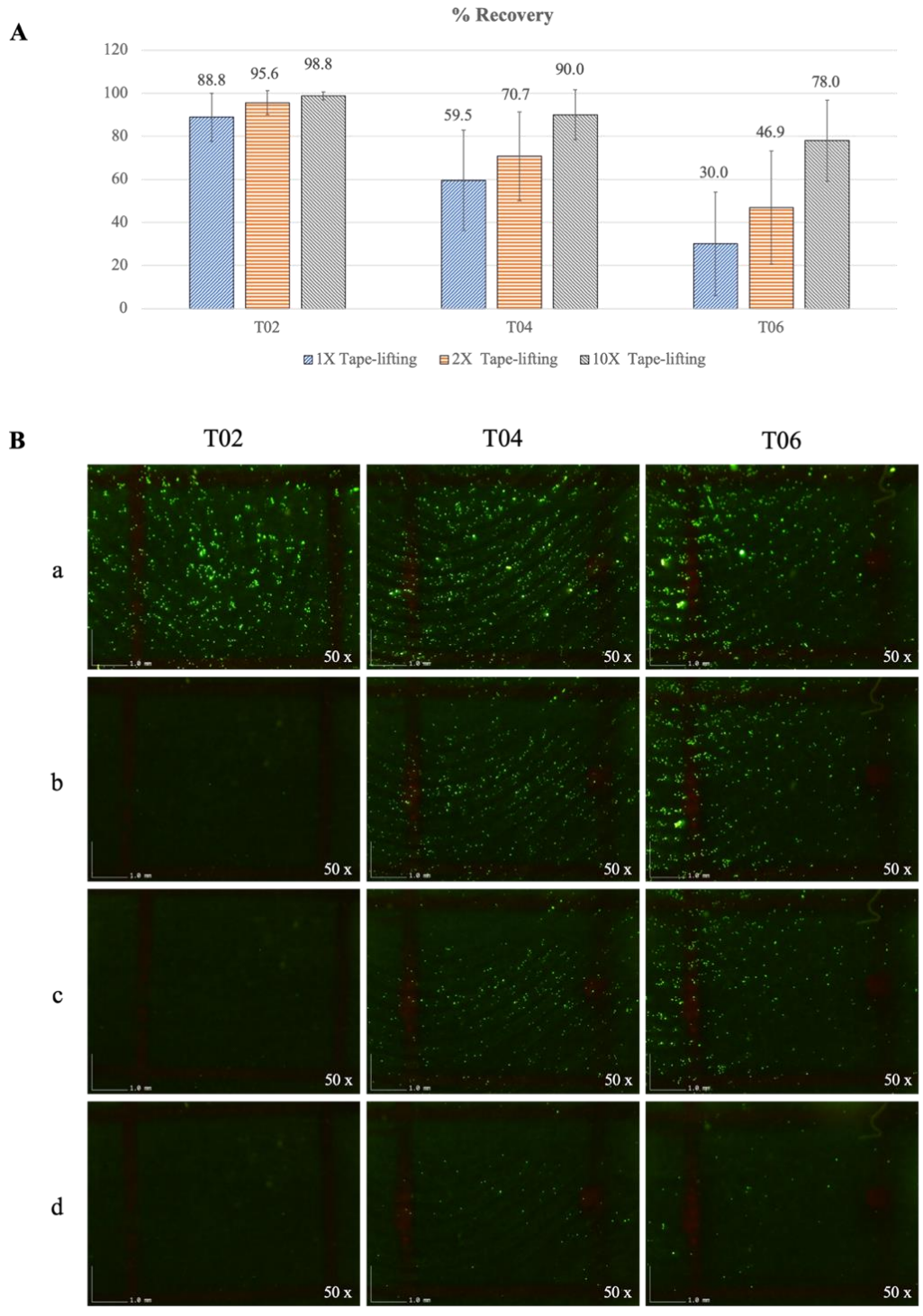

Fig. 3. Illustrating the efficiency of cellular material recovery of three types of tapes: brown packing Packmate™ tape (T02), clear Sellotape® (T04) and DNA-free Lovell tape (T06). Panel A shows the percentage of the recovery after tape-lifting once, twice and ten times. Panel B shows the stained cellular material present on the glass slide before tape-lifting (a), after tape-lifting once (b), twice (c) and ten times (d). The images were taken at 50x magnification in ambient light.

3.4 Mock samples on touched fabrics

After tape-lifting, DD staining, cutting and placing into a PCR tube shows in the Fig. 4. At 50x magnification, the collected cellular material on brown packing Packmate™ tape (T02, Fig 4A) was clearly visualised. Clear Sellotape® (T04, Fig. 4B) exhibited air-bubbles as a background effect. DNA-free Lovell tape (T06, Fig. 4C) showed faint background fluorescence which was higher than the other two tapes, although the stained cells can be visualised clearly on tapes, especially at 220x magnification. All touched fabrics that were tape-lifted using three tapes (T02, T04 and T06) produced full DNA profiles, comprising of all 15 STR loci plus amelogenin. All STR profiles were from a single source and matched that of the volunteer who touched the item. The average RFU for all dye channels of T02, T04 and T06 (n = 3) were 17,265.40, 13,629.27 and 11,870.89 respectively (Table S1).

The results showed informative DNA profiles could be obtained from the tapes after DD staining and when processed through the direct PCR approach. This supports a previous study that reported on obtaining of full DNA profiles matched with the donor from saliva stains after staining with DD, tapelifting and amplified using AmpFLSTR NGM SElect kit (29 cycles) with direct PCR technique [26].

A recent report showed that the reduced DNA yield and profiling success after DD staining compared with unstained samples [27]. These may be due to the use of a large volume (20 μL) of DD solution on tapes (25 mm x 25 mm) and rolling tapes when tape still wet [27]. In our finding, the volume used (5 μL) of DD diluted in 0.01% Triton™ X-100 could be covered the entire rectangular (25 mm x 5 mm) tape. Also, no inhibitory effect was observed when placed stained (~5 mm^2) tape directly into PCR.

(suggested Fig. 4)

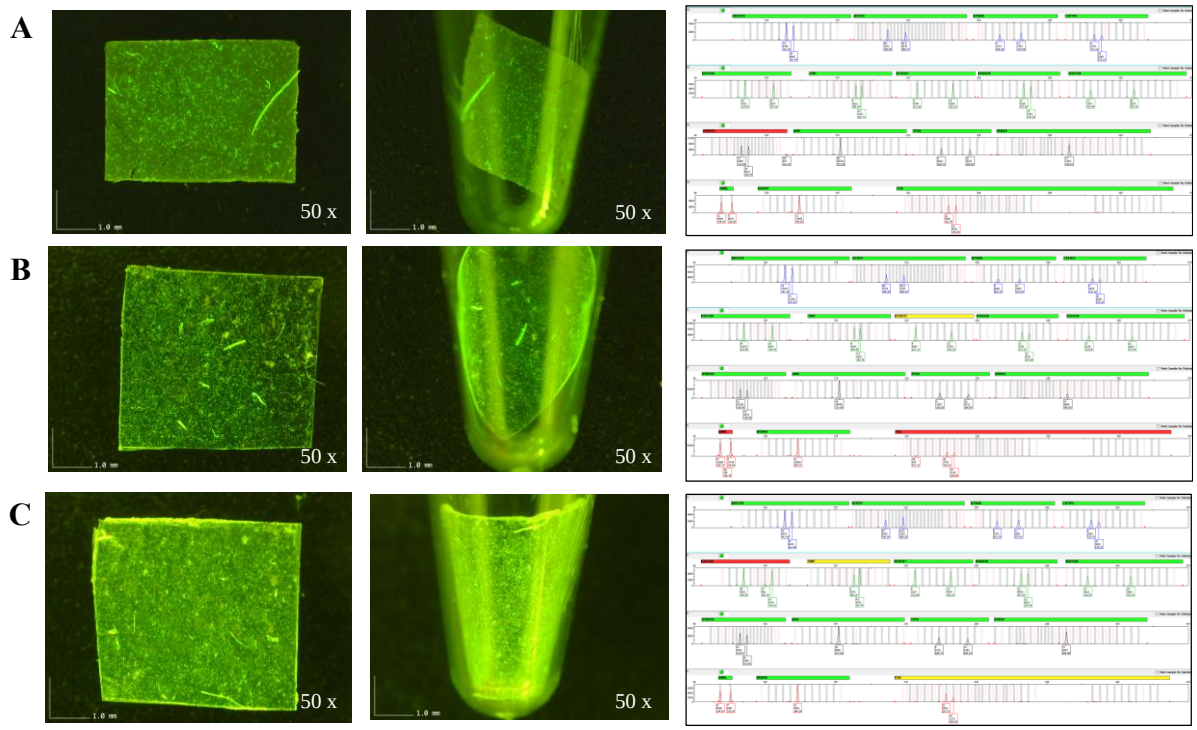

Fig. 4 Showing DNA profiles recovered from touched fabrics (100% cotton) by tape-lifting using three tested tapes: T02 (A), T04 (B) and T06 (C). Tapes were visualised (left), placed directly into a PCR tube (middle), and generated DNA profiles (right) using the AmpFLSTR® Identifiler® Plus kit (29 cycles).

(suggested Table S1)

Table S1 shows the STR data obtained using the AmpFLSTR® Identifiler® Plus kit (29 cycles). All DNA profiling was performed in triplicates. The percentage of amplified STR alleles were calculated based on 15 STR loci matched with volunteer's DNA profile. RFU data were obtained as an average RFU of each dye channel and all dye channels.

Tape	**Replicates**	**% success**	**Average RFU**					
			Blue channel	Green channel	Yellow channel	Red channel	All dye channels	Triplicate
T02	1	100.00	7,010.00	11,296.00	8,679.00	8,211.00	9,043.87	17,265.40
	2	100.00	36,413.75	32,678.20	32,257.00	24,460.00	32,466.27	
	3	100.00	8,930.50	11,329.20	10,149.75	10,662.00	10,286.07	
T04	1	100.00	3,410.50	5,278.60	4,537.00	3,443.50	4,338.00	13,629.27
	2	100.00	19,982.00	28,215.60	23,231.00	19,681.00	23,552.80	
	3	100.00	11,498.75	14,238.60	13,448.00	11,987.50	12,997.00	
T06	1	100.00	20,464.00	29,891.80	23,556.00	19,365.00	24,284.60	11,870.89
	2	100.00	2,697.50	4,984.60	3,801.50	3,439.50	3,853.20	
	3	100.00	6,129.00	8,812.40	7,542.50	6,687.50	7,474.87	
Negative PCR control		NR	NR	NR	NR	NR	NR	NR

NR: no result

4. Conclusions

The aim of this paper was to report on which tape, out of those tested, had least background fluorescence after DD staining, least inhibition to PCR and the greatest recovery of touch DNA. The results obtained showed that the three tapes (brown packing (Packmate™), clear (Sellotape®) and DNA-free (Lovell Surgical Solutions International Pty. Ltd,)), can effectively recover transferred DNA, can be applied to the recovery touch DNA on fabrics, and generate STR data using direct STR amplifications. The Lovell DNA-free tape is used commonly in forensic practice yet found to perform poorly compared to the two tapes that can be bought from stationery suppliers. It is noted that these store-bought tapes are not DNA-free and may not be suitable currently for forensic practice. However, the results illustrate that the adhesive properties of these cheap tapes are more effective at removing cells than more expensive speciality tapes sold to the forensic science community, therefore there could be scope for manufacturers to improve the performance of speciality tapes by altering the adhesive used in their products.

Staining tapes with 20x DD diluted with 0.01% Triton™ X-100 and visualisation when the dye solution has dried is recommended as there was less indication of background fluorescence. DD diluted with sterile water and 75% EtOH in sterile water is easy to spread, and it does not affect direct PCR and STR profiling. Three of the fourteen tapes were suitable types of tape for further analyses as they did not inhibit PCR or have intrinsic background fluorescence. Of the three, the tape used commonly in forensic laboratories performed more poorly in terms of collection of cells than the brown packing tape.

From this study, the DD staining of tapes collected from items of forensic interest can be applied quickly and easily. The use of the portable fluorescence microscope offers the possibility that a decision can be made quickly as to whether there are sufficient cells to warrant further testing.

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