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DNA profiling on fabrics: an in-situ method

Lay Hong Seah*, Mohd Izuan Othman, Primulapathi Jaya, N. Hithaya Jeevan

Forensic Division, Malaysian Department of Chemistry, Jalan Sultan, Petaling Jaya, Malaysia

Abstract. In the presence of sufficient DNA (from biological stains) on a binding substrate, multiplex PCR can be carried out in-situ without an extraction step. In this study, blood dried on six different fabrics, namely, cotton, rayon, nylon, wool, acrylic and polyester were tested. Multiplex PCR using the AmpF*l*STR Identifiler kit on a 2- to 3-mm square bloodstain successfully amplified the DNA from cotton, rayon, nylon and wool. A partial profile was obtained from the bloodstain on acrylic. No profile was obtained from the bloodstain on polyester. The binding properties of these various fabrics with DNA were investigated in this study.

Keywords: Fabrics; Cotton; Rayon; Nylon; Wool; Acrylic; Polyester; AmpF*l*STR identifiler; In-situ DNA profiling; STR

1. Introduction

Natural cellulose fibers, e.g. cotton or man-made cellulose fibers, e.g. rayon chemically consists of linked glucose units with free hydroxyl units which can provide sites for linkages. Polyamide fibers like nylon are a synthetic fiber with amide (–CONH–) linkages. Wool is a protein fiber made up of amino acids. Polyester is a synthetic fiber composed of units of an ester of a substituted aromatic carboxylic acid. Acrylic is a synthetic polymer composed of acrylonitrile units ($-CH_2-CHCN-$) [1]. The presence of biological fluids, e.g. blood, semen or saliva on fabrics (clothing or bedding items) present one of the most important evidentiary materials from a crime scene [2]. The ability to type DNA directly from various types of fabrics was investigated in this study.

2. Materials and method

A preserved blood sample (with normal blood counts) was loaded and dried on six types of fabrics, namely cotton, rayon, nylon, wool, acrylic and polyester. A 2-mm square bloodstain was taken from the cotton, rayon, nylon and wool fabrics, and a 3-mm square bloodstain was taken from acrylic and polyester fabrics due to the relatively bigger stain area. The stains were purified in-situ and subsequently amplifed directly (at days 1 and 14)

* Corresponding author. Tel.: +603-79853840; fax: +603-79581173.
E-mail address: lhseah@kimia.gov.my (L.H. Seah).

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using the AmpFlSTR Identifiler kit. The DNA typing was carried out on the ABI 3100 Genetic Analyzer and profiles were analyzed by GeneScan (version 3.7) and Genotyper 3.7 software [3].

3. Results and Discussion

At day 1, the DNA from cotton, nylon, rayon and wool fabrics were successfully amplified generating full DNA profiles (Fig. 1) with more intense profiles from cotton and

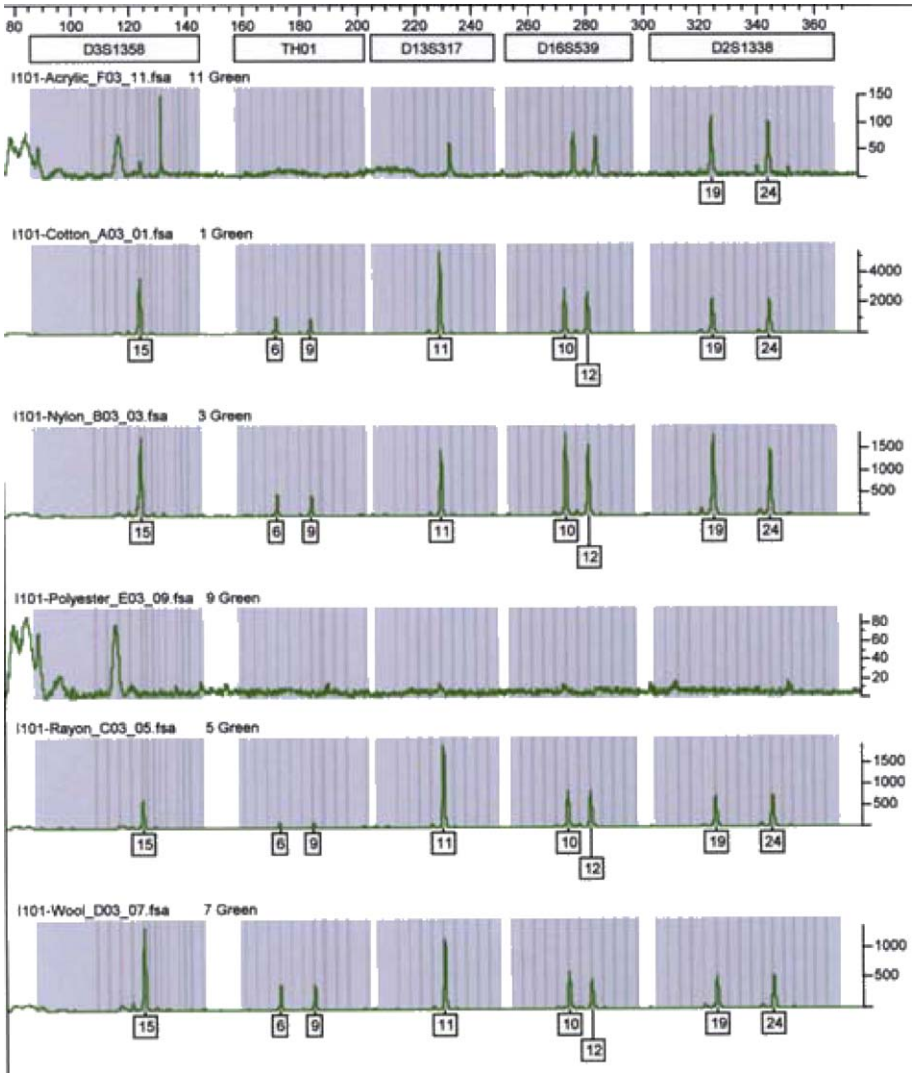

Fig. 1. Day 1—DNA profiles at the green loci D3S1358, TH01, D13S317, D16S539 and D2S1338 of AmpFlSTR Identifiler typing kit for (top to bottom) acrylic, cotton, nylon, polyester, rayon and wool.

nylon. A partial profile was obtained from acrylic and no DNA profile was derived from polyester. It is interesting to note that for DNA on acrylic amplification for the bigger alleles were generally more successful.

Amplification on the 14-day old bloodstains generated almost complete DNA profiles for cotton and nylon and a less complete profile for rayon but relatively less intense profiles compared to the fresh bloodstains (figure not shown). The DNA profile from acrylic showed no significant variation after 14 days.

The presence of functional groups on fibers permit molecular chains (intrinsic or extrinsic) to be held together by the operation of strong intermolecular forces–hydrogen bonding, dipole–dipole attractions and van der Waals forces [4,5]. The O–H groups of cotton and rayon and the N–H groups of nylons and wool are capable of strong hydrogen bonding with nucleic acid chains resulting in powerful intermolecular attractions, hence facilitating an in-situ amplification on the solid template with possible deterioration of the attractive forces with time. Polyesters and acrylics contain polar carbonyl (C=O) and cyano (C≡N) groups which permit relatively weaker dipole–dipole attraction with nucleic acid chains. The null amplification from polyesters could be due to inefficient intermolecular forces between polyesters and nucleic acids. The efficiency of the in-situ technique for the six different fabrics in decreasing order are cotton = nylon>rayon>wool>acrylic>polyester.

The ability to obtain a DNA profile by in-situ amplification from a small stained area (1–10 mm^2 area) without extraction of DNA from the fabric becomes important when biological stains are available on a small area where recovery of usable DNA for typing may be adversely reduced by an extraction process and when quick results are demanded. Biological stains on fabrics like cotton and nylon can be typed directly and stains on non-absorbent surfaces like glass and plastics can be swabbed up onto cotton cloth.

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