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TECHNICAL NOTE

Comparison of laser and mercury-arc lamp for the detection of body fluids on different substrates

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Abstract The performance of two detection techniques for body fluids, the Spectra-Physics® Reveal™ portable forensic laser system and the mercury-arc lamp Lumatec Superlite 400, was evaluated with various biological stains on different substrates. Serial dilutions of neat, 1/10, 1/100 and 1/1,000 using fluid semen, saliva, urine and blood were applied on glazed tiles, glass, PVC, wood, metal, stone, formica, carpet and cotton. Apart from the fact that blood traces were not detectable with the laser, both light sources showed comparable results regarding their detection capability. Clear advantages of the Lumatec Superlite 400, however, are its lower size, weight, purchase costs and the possibility to operate this light source by battery.

Keywords Forensic science · Body fluids · Laser · Mercury-arc lamp · Blood · Urine · Saliva · Semen

Introduction

The detection of biological stains at crime scenes is a challenging procedure for forensic investigators. The methods used must be as sensitive as possible but should not affect the traces, allowing subsequent DNA analysis. White light, ultraviolet light and laser light comply with these requirements, as numerous body fluid stains fluoresce under these light sources [1, 2]. The capability of two new light sources for forensic purposes, the Spectra-Physics® Reveal™ portable forensic laser system and the mercury-arc lamp Lumatec Superlite 400, was evaluated with various biological stains on different surfaces. Both equipment are especially designed for crime scene investigation. The laser system is completely encased with wheels and retractable handle, but needs a power supply and has a weight of 37 kg. Just weighing 6.2 kg, the mercury-arc lamp is completely stored in a kind of shoulder bag and can be battery-operated.

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Materials and methods

Serial dilutions of neat, 1/10, 1/100 and 1/1,000 were made from fluid semen, saliva, urine and blood from one laboratory donor. Due to subsequent DNA typeability, the dilution series were stopped at 1/1,000. From each specimen, 1 ml was applied to glazed tiles, glass, PVC, wood, metal, stone, formica, carpet and cotton. The stained materials were examined 2 weeks later with the two light sources.

The Spectra-Physics® Reveal™ portable forensic laser head (Newport Spectra-Physics Lasers Division, Mountain View, CA, USA) generates a continuous green beam with a wavelength of 532 nm. The system used in this study delivers 8 W of laser power. The green beam is delivered to a small wand through a fiber-optic cable with a length of 7.5 m. The objects have to be viewed through laser-safe eye wear (orange, 532 nm).

The Lumatec Superlite 400 mercury-arc lamp (Lumatec, Deisenhofen, Germany) has a spectral range from 320 to 700 nm, divided into 10 spectra selectable by filter wheel. Light is delivered through a flexible light guide with a length of 1.8 m. The related output has to be selected manually according to the selected filter and the appropriate goggles have to be worn. The filter positions, power output

Table 1 Mercury-arc lamp Lumatec Superlite 400 filter positions, power output and goggles selected for the different traces (manufacturer's recommendations)

Stain	Filter position	Spectrum (nm)	Power output (W)	Goggles
Semen	4	415 violet	1.9	Orange
Urine	2	400–500 blue	5.5	Orange
Saliva	3	320–400 UVA	1.9	Transparent
Blood	4	415 violet	1.9	No goggles

and goggles selected for the different traces are listed in Table 1.

Results and discussion

Laser light and mercury-arc light take advantage of the inherent luminescence of various body fluids to make traces detectable. The results of the tests with the Spectra-Physics® Reveal™ portable forensic laser system and the mercury-arc lamp Lumatec Superlite 400 are summarized in Table 2. Both light sources showed comparable results in detection capability for semen, saliva and urine with a slightly better sensitivity of detection of the laser system regarding saliva. Although the fluorescence of urine was stronger when using the laser system, the detection capability of the mercury-arc lamp was better on the substrates carpet, stone and cotton. Both pieces of equipment allow rapid screening of large surfaces and the detection of traces that are not visible to the naked eye (Fig. 1). An advantage of the laser system is the need for just one examination for all kinds of detectable body fluids. The type of trace, however, can be estimated by the investigator only roughly, as the differences especially between urine and saliva, which both fluoresce yellow-orange are marginal (Fig. 2). Due to the different filters and goggles that have to be selected for different traces, the Lumatec Superlite 400 facilitates a preliminary rough valuation of the kind of the body fluids but therefore requires several successive examinations. However, one has to keep in mind that both methods are only unspecific approaches that just offer a presumptive test for body fluids and cannot replace modern specific test procedures [3–6].

As there is complete light absorption at the emitted wavelength of 532 nm, the detection of blood is not possible with the laser system (Table 2). Further clear

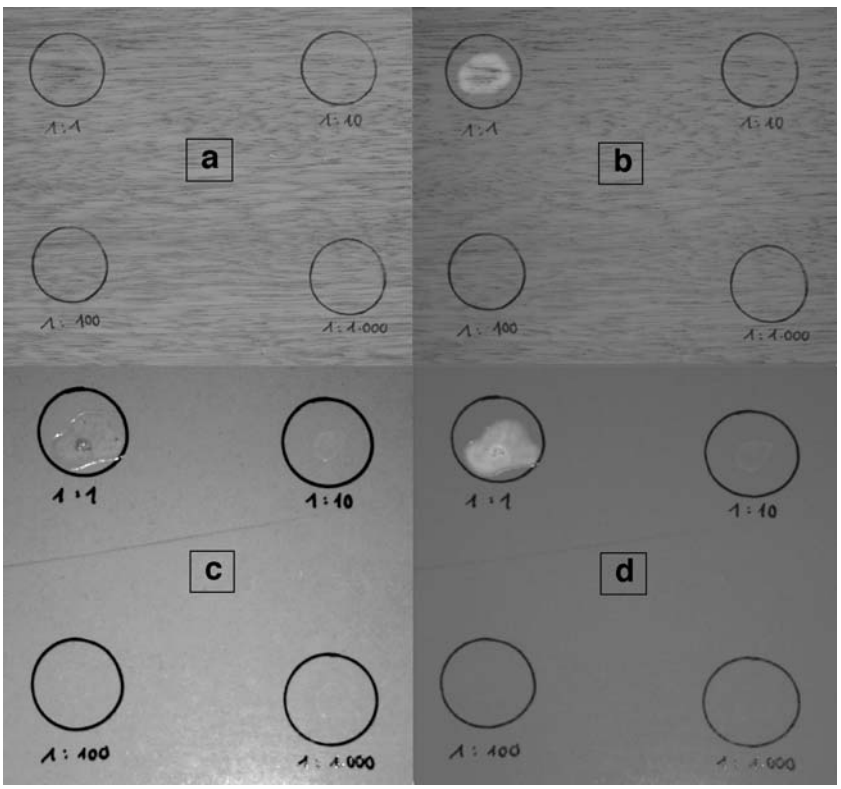
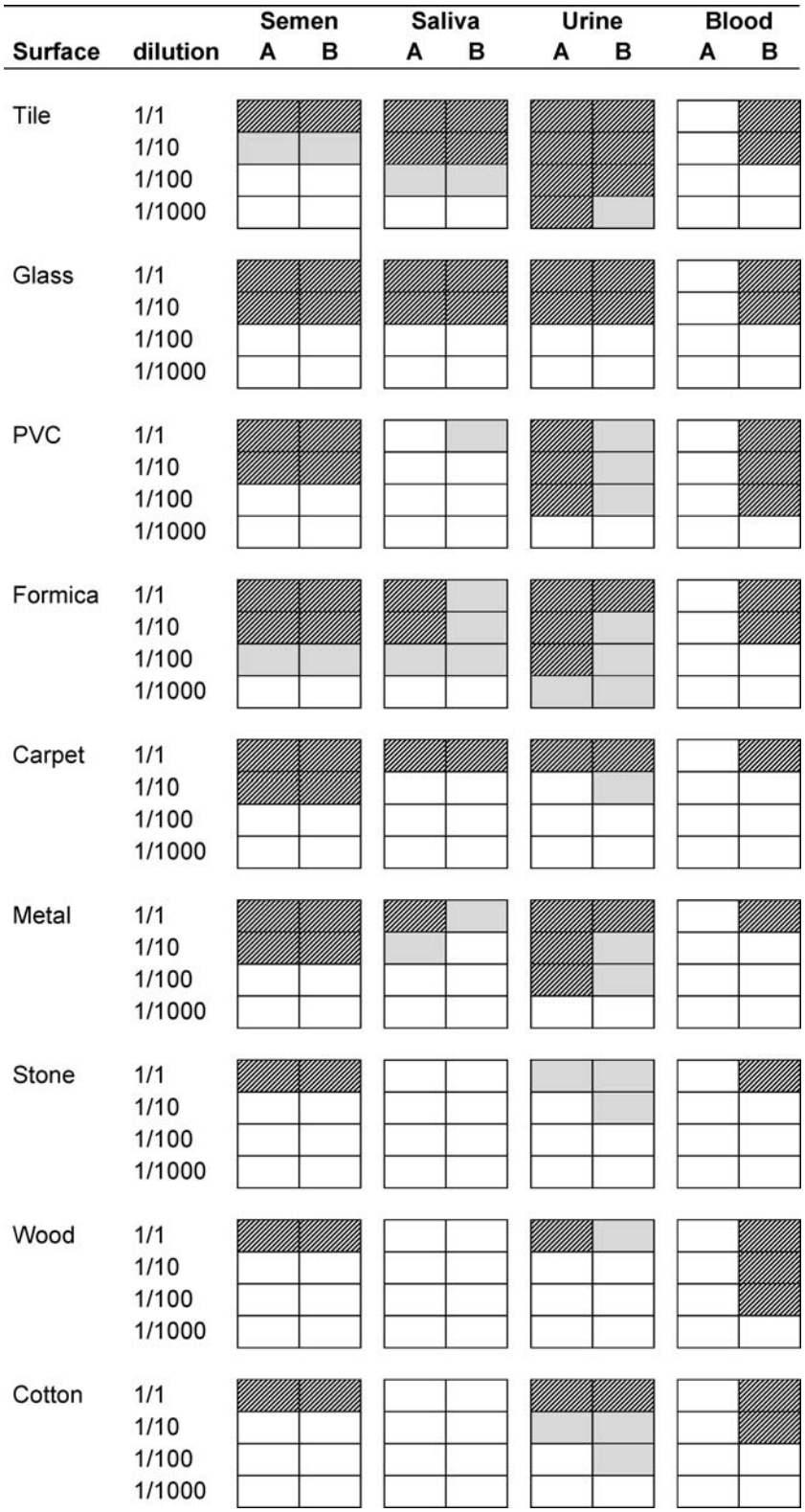


Fig. 1 Semen (neat and in different dilutions) applied on wood and tile. **a** and **b** Semen on wood. **a** Daylight view. **b** View with the Spectra-Physics® Reveal™ portable forensic laser. **c** and **d** Semen on tile. **c** Daylight view. **d** View with the Spectra-Physics® Reveal™ portable forensic laser

Table 2 Detection capability of both light sources for serial dilutions of semen, saliva, urine and blood stains on different surfaces



Diagonally hatched boxes strong; *grey boxes* weak.
A: Spectra-Physics Reveal laser, *B*: Lumatec Superlite 400 mercury-arc lamp

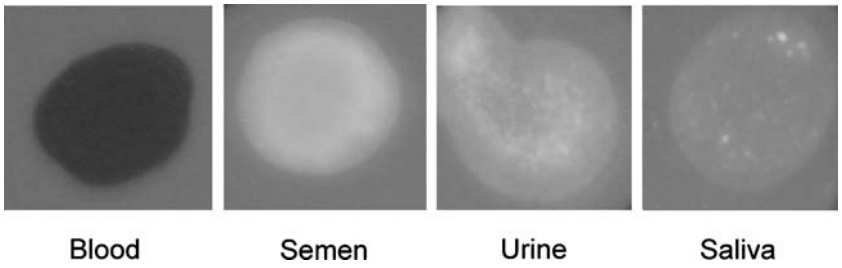


Fig. 2 View of neat blood, semen, urine and saliva on a glass surface with the Spectra-Physics® Reveal™ portable forensic laser. While blood gives no light reaction at all, semen lights up in yellow-greenish and urine and saliva in yellow-orange

advantages of the Lumatec Superlite 400 are its lower size, weight and purchase costs. In addition, the mercury-arc light system can be battery-operated independent of a power supply for 60 min and the battery can be changed within seconds.

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