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An Evaluation of Collection Devices in High-Volume Databasing

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Background

Bode Cellmark Forensics has been processing databasing samples for local, state, and federal agencies for over 20 years. Over this time, Bode Cellmark has worked on over thirty projects that have resulted in the completion of nearly three million databasing samples. Often times when data is presented on the success rate of collection devices, it is based on a limited number of samples that were properly collected in a controlled environment. This study aimed to compare the first pass success rates and overall failure rates of different substrates using a large sample set of field collected offender and arrestee samples to better represent the actual performance. The impact of the collection device on sampling efficiency was also evaluated.

Methods

All buccal samples were robotically extracted using the Qiagen BioSprint 96 kit. Blood samples were extracted using either the Qiagen BioSprint 96 or Whatman® FTA® Purification Reagent. PCR Kits varied by contract and included Identifiler®, Identifiler® Plus, PowerPlex®16 and PowerPlex®16HS run on an ABI 3130xl, and PowerPlex® Fusion run on a 3500xl. To evaluate the overall failure rate of collection devices, data was collected for all databasing samples tested at Bode Cellmark Forensics from 2011 through 2016. The total number of failed samples for each substrate was tallied and calculated as a percentage of the total number of samples tested for that substrate. A failed sample was defined as one that did not result in a full 16 STR locus profile that met all contractual specifications after a minimum of three amplifications including at least one DNA re-extraction.

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To evaluate the first pass success rate, data was collected for all buccal samples processed for DNA analysis within the past twelve months. First pass success rate was defined by the percentage of samples that met all reporting guidelines on the first run. Samples that required re-injection, re-amplification, or re-extraction for any reason were not counted as acceptable in the first pass success rate. Re-run reasons could include, but were not limited to, capillary electrophoresis failures, alleles above or below required RFU thresholds, and confirmation of off-ladder or micro-variant alleles, PCR artifacts, allelic imbalances and tri-allelic loci.

To compare sampling efficiency, analysts and technicians were surveyed on the amount of time spent to sample one plate of 87 samples for each substrate.

Results

Blood-stained cards had the lowest failure rate followed by Bode Buccal DNA Collectors and then cotton-tipped swabs. Saliva-stained treated cards had the highest overall failure rate. See Table 1.

Table 1 - Overall Failure Rate Over 5 Years

Sample Substrate	Samples Tested	Failed Samples	Failure Rate
Blood-stained cards	22,014	12	**0.05%**
Bode Buccal DNA Collectors	239,352	255	**0.11%**
Cotton-tipped swabs	86,504	177	**0.20%**
Saliva-stained treated cards	94,704	643	**0.68%**

Bode Buccal DNA Collectors and cotton-tipped swabs had similar first pass success rates. However, the swabs were quantified and diluted as necessary prior to amplification, while the Bode Buccal DNA Collector workflow went directly from extraction to PCR, saving both time and reagent costs. Saliva-stained treated cards had the lowest first pass success rate. See Table 2.

Table 2 – First Pass Success Rate Over 12 Months

Sample Substrate	Samples Tested	First Pass Rate	Reload Rate	Re-Amp/Re-Extract Rate
Bode Buccal DNA Collectors	30,166	**90.89%**	3.95%	5.15%
Cotton-tipped swabs	55,175	**89.36%**	3.94%	6.69%
Saliva-stained treated cards	12,958	**78.34%**	4.32%	17.34%

Bode Buccal DNA Collectors and blood- and saliva-stained treated cards were compatible with semi-automated sampling on the BSD600 Duet Puncher while cotton-tipped swabs required more laborious manual cutting. Bode Cellmark's policy for database testing requires any manual transfer of sample material to be witnessed by a second individual. Therefore, it required labor hours of two people as opposed to one person operating the BSD600 Duet Puncher. The labor time to sample cotton-tipped swabs was three times that of other substrates. See Table 3 for summary of observed sampling times per plate and estimated times for larger batches.

Table 3 – Sampling Efficiency

	Bode Buccal DNA Collectors, Blood and Saliva Stained Cards	Cotton-Tipped Swabs
Sampling Method	BSD600 Duet Puncher	Manual cutting with witness
Labor Hours Per Plate	0.50	1.50
Est. Labor Hours Per 1,000 samples	5.75	17.25
Est. Labor Hours Per 5,000 samples	28.75	86.25

Conclusions

Blood samples demonstrated the lowest overall failure rate. However, blood collections have become less common due to the expense, invasiveness of collections and the risk of exposure to blood-borne pathogens. The Bode Buccal DNA Collector had the highest first pass success rate and lowest overall failure rate of all buccal collections. This is likely attributable to the direct collection method that does not require a secondary transfer to a card. Cotton-tipped swabs also allow for direct collection, but the manual cutting of the swab makes this a less efficient device for downstream processing.