Purification of Forensic DNA Samples with the KingFisher® Magnetic Particle Processor and Characterization of the Purified DNA

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Introduction

Due to the large number of samples processed for complete databases and pressing court dates for forensic analysis of case exhibits, DNA extraction methods that are rapid and produce large amounts of highly purified DNA are required. The KingFisher automated DNA extraction system was assessed for its suitability for forensic DNA applications. The system was tested for its efficiency in extracting DNA from a number of biological substrates, including blood, buccal and hair samples.

Materials and Methods

2.1 DNA purification

DNA from different types of forensic samples was purified with four different commercial DNA purification kits:

- AGOWA® mag Maxi DNA Isolation Kit, Cat. No. 40403, AGOWA, Germany
- AGOWA® mag DNA Isolation Sputum Kit, Cat. No. 40510, AGOWA, Germany
- InviMag Blood DNA Mini Kit, Cat. No. 10311602, Invitek mbH, Germany
- InviMag Forensic Kit, Cat. No. 74343002, Invitek mbH, Germany

Blood samples were purified with all four kits so that 200 µl of fresh blood was directly used as a sample with the AGOWA mag Maxi DNA Isolation Kit and the InviMag Blood DNA Mini Kit. With the AGOWA mag DNA Isolation Sputum Kit and the InviMag Forensic Kit, blood spots of 30 µl were placed on IsoCode Card paper after which the spots were dried at room temperature for three hours. After drying, two three-millimeter disks were punctured from the paper and used as a sample in the purification. All blood samples were purified with the KingFisher mL and KingFisher 96 magnetic particle processors.

Buccal samples were collected with sterile cotton swabs and epithelian cells were extracted directly from the swabs for DNA purification. Purifications were performed with the AGOWA mag DNA Isolation Sputum and the InviMag Forensic Kits. The AGOWA mag DNA Isolation Sputum Kit was used with both the KingFisher mL instrument and the KingFisher 96 instrument and the InviMag Forensic Kit was only used with KingFisher mL.

With hair samples, 1 – 3 hair roots were used as such without any pretreatment of the sample. The hair samples were purified using the InviMag Forensic Kit and only with the KingFisher mL instrument.

In all cases, samples were mixed with appropriate lysis buffer, an optimized amount of Proteinase K was added, and the samples were incubated at elevated temperatures for a certain time. After the incubation, the samples were processed in KingFisher 96 or KingFisher mL using appropriate plastics (96-well plates, tip combs, and tube strips, depending on the instrument). Purification protocols from the kit inserts were taken as starting points for protocol optimization. The protocols were then optimized separately for each sample type and for both instruments to obtain the maximum possible DNA yield from each sample type by testing different volumes of reagent additions, number of washing steps, incubation times and temperatures.

3 DNA characterization

The resulting purified DNA from different samples and purification procedures with different instruments was characterized using both photometric and fluorometric analysis.

Photometric UV spectra and absorbances at 260 and 280 nm of the DNA samples were measured from fresh blood samples or other samples except those purified with the AGOWA mag DNA Isolation Sputum Kit. Measurements were performed with Thermo's Varioskan® spectral scanning multimode reader. A 40 µl aliquot of each DNA sample was transferred into 384-well UV-microplates (UV-Star, Greiner BioOne GmbH, Germany) and DNA spectra were measured with the following settings: spectral scanning area 240 – 360 nm, wavelength stepping 1 nm, bandwidth 5 nm, measurement time 100 ms, liquid settling delay 100 ms. The DNA concentration of each sample was calculated based on the absorbances at 260 nm using 320 nm absorbances as reference blank values.

The high-sensitivity, quantitative DNA assay was performed with Thermo's Fluoroskan Ascent® microplate fluorometer and the Quant-iT™ PicoGreen® dsDNA Assay Kit (Invitrogen Inc., USA) from the sample purified with the AGOWA mag Maxi DNA Isolation Kit or the AGOWA mag DNA Isolation Sputum Kit. Purified DNA samples were diluted 1:10 with TE-buffer and 100 µl of the dilution was transferred into white 96-well strip plates (Thermo Electron, Finland). Sample plates were placed into the fluorometer and 100 µl of PicoGreen reagent (diluted 1:200) was added with an automatic dispenser into every well. Fluorescence was read after a short mixing with 485 nm excitation and 538 nm emission wavelengths. DNA concentrations were determined based on a seven-concentration DNA calibration curve between 0.125 – 2 µg/ml prepared from the control DNA samples included with the purification kits.

4 Results

4.1 DNA purification

4.1.1 Blood samples with AGOWA mag Maxi DNA Isolation and InviMag Blood DNA Mini Kits

Fresh blood samples with the AGOWA mag Maxi DNA Isolation Kit and the InviMag Blood DNA Mini Kit were purified with both the KingFisher mL instrument and the KingFisher 96 instrument. Optimized purification protocols for the AGOWA kit are shown in Table I and protocols for the Invitek kit in Table II.

Table I. Optimized DNA purification protocols for KingFisher instruments with AGOWA mag Maxi DNA Isolation Kit for blood samples.

	KingFisher mL		KingFisher 96
		Plate 1	KF96 plate and KF96 Tip comb
Tube A	200µl Lysis buffer + 20 µl Proteinase K + 200 µl blood, mix for 10 s, incubate covered at +55 C for 10 min. Add 200 µl 96% Ethanol and 20 µl magnetic particles	**Plate 2 (Thermo dw plate)**	200 µl Lysis buffer + 20 µl Proteinase K + 200 µl blood, mix for 10 s, incubate covered at +55 C for 10 min. Add 200 µl 96% Ethanol and 20 µl magnetic particles
	Starting KingFisher automatic protocol		Starting KingFisher automatic protocol
	Mixing, grind mix 1 min, fast 3 min, collect 3x		Mixing, grind mix 1 min, superfast 3 min, collect 3x
Tube B	Washing buffer BLM 1, 700 µl, mixing, fast dual mix 1 min, collect 2x	**Plate 3 (Thermo dw plate)**	Washing buffer BLM 1, 500 µl, mixing, grind mix 1 min, half mix 1 min, collect 2x
Tube C	Washing buffer BLM 2, 700 µl, mixing, fast dual mix 1 min, collect 2x	**Plate 4 (Thermo dw plate)**	Washing buffer BLM 1, 500 µl, mixing, grind mix 30 s, haft mix 30 s, collect 2x
Tube D	Washing buffer BLM 2, 700 µl, mixing, fast dual mix 1 min, collect 2x, drying 30 min	**Plate 5 (Thermo dw plate)**	Washing buffer BLM 2, 500 µl, mixing ,grind mix 1 min, half mix 1 min, collect 2x
Tube E	Elution buffer BLM, 200 µl, mixing, bottom medium 1 min, incubation +55 C 10 min (outside of the instruments), post mix 2 min, collect 3x, beads released into Tube A	**Plate 6 (Thermo dw plate)**	Washing buffer BLM 2, 500 µl, mixing, grind mix 30 s, half mix 30 s, collect 2x, removal of acetone 10 min
		Plate 7 (KF96 plate)	Elution buffer D, 200 µl, heating (preheat) + 65 C, mixing, medium 10 min, post mix slow 20 s, collect 3x , beads released into Plate 6
	Total purification time 45 min + 10 min		**Total purification time 37 min**

Table II. Optimized DNA purification protocols for KingFisher instruments with InviMag Blood DNA Mini Kit for blood samples.

	KingFisher mL		KingFisher 96
		Plate 1	KF96 plate and KF96 Tip comb
Tube A	200µl Lysis buffer + 20 µl Proteinase K + 200 µl blood, mix for 10 s, incubate covered at +56 C for 10 min with shaking 900 rpm	**Plate 2 (Thermo dw plate)**	200 µl Lysis buffer + 20 µl Proteinase K + 200 µl blood, mix for 20 s, incubate covered at +70 C for 20 min, mixing after every 5 min.
	Starting KingFisher automatic protocol		Starting KingFisher automatic protocol
	Lysate from above (420µl) + Binding Buffer B6, 400 µl + 10 µl MAP Solution A, mixing, grind mix 1 min, half mix 2 min, collect 3x		Add 400µl Binding buffer B6 and 10 µl MAP solution, mixing, grind mix 1 min, superfast 2 min, collect 3x
Tube B	Wash Buffer I, 800µl, mixing, fast dual mix 1 min 30 s, collect 2x	**Plate 3 (Thermo dw plate)**	Washing buffer I, 500 µl, mixing, grind mix 1 min, half mix 2 min
Tube C	Wash Buffer II, 800 µl, mixing, fast dual mix 40s, collect 2x	**Plate 4 (Thermo dw plate)**	Washing buffer I, 500 µl, mixing, half mix 2 min
Tube D	Wash Buffer II, 800µl, mixing, fast dual mix 30 s, collect 2x, drying of ethanol 8 min	**Plate 5 (Thermo dw plate)**	Washing buffer II, 800 µl, mixing, grind mix 1 min, half mix 1 min, collect 2x
Tube E	Elution Buffer D, 200µl, mixing, medium 5 min, collect 3x, beads released into Tube D	**Plate 6 (Thermo dw plate)**	Washing buffer II, 800 µl, mixing, grind mix 1 min, half mix 1 min, collect 2x, drying of ethanol 8 min
		Plate 7 (KF96 plate)	Elution buffer D, 200 µl, mixing, slow 2min, heating (preheat) 2 min +80 C, tip heads within the liquid, postmix 1 min very slow, collect 3x, beads released into Plate 5
	Total purification time 25 min		**Total purification time 33 min**

4.1.2 Dried blood spots from disk with AGOWA mag DNA Isolation Sputum and InviMag Forensic Kits

Dried blood spots from the disks were purified with the AGOWA mag DNA Isolation Sputum and the InviMag Forensic Kits. Optimized purification protocols for the AGOWA kit are shown in Table III and protocols for the Invitek kit in Table IV.

Table III. Optimized DNA purification protocols for KingFisher instruments with AGOWA mag DNA Isolation Sputum Kit for dried blood disk samples.

	KingFisher mL		KingFisher 96
		Plate 1	KF96 plate and KF96 Tip comb
Tube A	250 µl lysis buffer + 5 µl Proteinase K + 2 pc. disks with blood, incubate covered at +55 C for 5 min. Add 200 µl Binding Buffer and 20 µl magnetic particles	**Plate 2 (Thermo dw plate)**	250 µl lysis buffer + 5 µl Proteinase K + 2 pc. disks with blood, incubate covered at +55 C for 5 min. Add 500 µl Binding Buffer and 20 µl magnetic particles
	Starting KingFisher automatic protocol		Starting KingFisher automatic protocol
	Mixing, grind mix 1 min half mix 3 min, collect 3x		Mixing, grind mix, 1 min half mix 3 min, collect 3x
Tube B	Washing buffer 1, 500 µl, mixing, grind mix 1 min 30 s, collect 2x	**Plate 3 (Thermo dw plate)**	Washing buffer 1, 500 µl, mixing, grind mix 1 min 30 s, collect 2x
Tube C	Washing buffer 2, 500 µl, mixing, half mix 1min 3 0s, collect 2x, drying of acetone 10 min	**Plate 4 (Thermo dw plate)**	Washing buffer 2, 500 µl, mixing, grind mix 30 s, half mix 30 s, collect 2x, drying of acetone 10 min
Tube D	Elution buffer D, 100 µl, mixing, medium 20 s, incubation +55 C 10 min (outside of the instrument), slow 10 min, collect 3x, beads released into Tube C	**Plate 5 (KF96 plate)**	Elution buffer D, 100 µl, mixing, fast 20 s, incubation +65 C, mixing slow 10 min, collect 3x, beads released into Plate 4
	Total purification time 32 +10 min		**Total purification time 33 min**

Table IV. Optimized DNA purification protocols for KingFisher instruments with InviMag Forensic Kit for dried blood disk samples.

	KingFisher mL		KingFisher 96
		Plate 1	KF96 plate and KF96 Tip comb
Tube A	600 µl Lysis buffer + 25 µl Proteinase K + 2 pc. disks with blood, incubate over night covered at +42 C with shaking at 900 rpm.	**Plate 2 (Thermo dw plate)**	600 µl Lysis buffer + 25 µl Proteinase K + 2 pc. disks with blood, incubate over night covered at +42 C with shaking at 900 rpm.
	Starting KingFisher automatic protocol		Starting KingFisher automatic protocol
	Lysate from above (625µl) + 300 µl Binding Buffer T + 20 µl MAP Solution A, mixing, grind mix 1 min, fast 2 min, collect 3x		Lysate from above (625µl) + 300 µl Binding Buffer T + 20 µl MAP Solution A, mixing, grind mix 1 min, superfast 2 min, collect 3x
Tube B	Wash Buffer I, 800µl, mixing, fast dual mix 50 s, collect 2x	**Plate 3 (Thermo dw plate)**	Wash Buffer, 800µl, mixing, grind mix 30 s, half mix 30 s, collect 2x
Tube C	Wash Buffer II, 800 µl, mixing, fast dual mix 50 s, collect 2x, drying of ethanol 8 min	**Plate 4 (Thermo dw plate)**	Was Buffer, 500 µl, mixing, grind mix 30 s, half mix 30 s, collect 2x
Tube D	Elution Buffer D 120µl, mixing, medium 5 min, collect 3x, beads released into Tube C	**Plate 5 (Thermo dw plate)**	Wash Buffer, 800 µl, mixing, grind mix 30 s, half mix 30 s, collect 2x, drying of ethanol 8 min
		Plate 6 (KF96 plate)	Elution buffer D, 100 µl, mixing, slow 2 min, heating +80 C 2 min, tip head within the liquid, postmix 1 min very slow, collect 3x, beads released into Plate 3
	Total purification time 23 min		**Total purification time 24 min**

4.1.3 Buccal samples with AGOWA mag DNA Isolation Sputum and InviMag Forensic Kits

Buccal samples were purified with the AGOWA mag DNA Isolation Sputum and InviMag Forensic Kits. The AGOVA kit was used with both KingFisher models and the Invitek kit only with KingFisher mL. Optimized purification protocols for the AGOWA kit are shown in Table V and protocols for the Invitek kit in Table VI.

Table V. Optimized DNA purification protocols for KingFisher instruments with AGOWA mag DNA Isolation Sputum Kit for buccal samples.

	KingFisher mL		KingFisher 96
		Plate 1	KF96 plate and KF96 Tip comb
Tube A	250 µl Lysis buffer + 5 µl Proteinase K + cotton swab with sample, incubate covered at +55 C for 5 min.	**Plate 2 (Thermo dw plate)**	250 µl Lysis buffer + 5 µl Proteinase K + cotton swab with sample, incubate covered at +55 C for 5 min.
	Starting KingFisher automatic protocol		Starting KingFisher automatic protocol
	Add 200 µl Binding Buffer and 20 µl magnetic particles, mixing, grind mix 1 min, half mix 3 min, collect 3x		Add 500 µl Binding Buffer and 20 µl magnetic particles, mixing, grind mix 1 min, half mix 3 min, collect 3x
Tube B	Washing buffer 1, 500 µl, mixing, grind mix 1 min 30 s, collect 2x	**Plate 3 (Thermo dw plate)**	Washing buffer 1, 500 µl, mixing, grind mix 1 min 30 s, collect 2x
Tube C	Washing buffer 2, 500 µl, mixing, half mix 1 min 30 s, collect 2x, drying of acetone 10 min	**Plate 4 (Thermo dw plate)**	Washing buffer 2, 500 µl, mixing, grind mix 30 s, half mix 30 s, collect 2x, drying of acetone 10 min
Tube D	Elution buffer D, 100 µl, mixing, medium 20 s. incubation +55 C 10 min (outside of the instrument), slow 10 min, collect 3x, beads released into Tube C	**Plate 5 (KF96 plate)**	Elution buffer D, 100 µl, mixing, fast 20 s, incubation +65 C, mixing slow, collect 3x, beads released into Plate 4
	Total purification time 32 +10 min		**Total purification time 33 min**

Table VI. Optimized DNA purification protocols for KingFisher mL with InviMag Forensic Kit for buccal samples.

	KingFisher mL
Tube A	600 µl Lysis buffer G + 25 µl Proteinase K + cotton swab with buccal sample, incubate covered at +56 C, 20 min with shaking at 900 rpm.
	Starting of KingFisher automatic protocol
	Lysate from above (625µl) + 300 µl Binding Buffer T + 20 µl MAP Solution A, mixing, grind mix 1 min, fast 2 min, collect 3x
Tube B	Wash Buffer I, 800µl, mixing, fast dual mix 50 s, collect 2x
Tube C	Wash Buffer II, 800 µl, mixing, fast dual mix 50 s, collect 2x, drying of ethanol 8 min
Tube D	Elution Buffer D 120µl, mixing, medium 5 min, collect 10x, beads released into Tube C
	Total purification time 24 min

4.1.4 Hair samples with InviMag Forensic Kit

DNA from the hair root samples was purified using the InviMag Forensic Kit and the KingFisher mL instrument. The optimized purification protocol is shown in Table VII.

Table VII. Optimized DNA purification protocols for KingFisher mL with InviMag Forensic Kit for hair root samples.

	KingFisher mL
Tube A	600 µl Lysis buffer G + 25 µl Proteinase K + 30 µl 1M DTT + 1 – 3 hair roots, incubate over night covered at +42 C with shaking at 900 rpm.
	Starting KingFisher automatic protocol
	Lysate from above (625µl) + 300 µl Binding Buffer T + 20 µl MAP Solution A, mixing, grind mix 1 min, fast 2 min, collect 3x
Tube B	Wash Buffer I, 800µl, mixing, fast dual mix 50 s, collect 2x
Tube C	Wash Buffer II, 800 µl, mixing, fast dual mix 50 s, collect 2x, drying of ethanol 8 min
Tube D	Elution Buffer D 120µl, mixing, medium 5 min, collect 10x, beads released into Tube C
	Total purification time 24 min

One of the most important factors in the DNA purification process is the speed of the purification process. Processing times of the different purification protocols developed in this work are shown in Table VIII.

Table VIII. Collected processing times of different DNA purification protocols.

	KingFisher mL			**KingFisher 96**		
	Hands-on time (min)	Automatic KingFisher processing time (min)	Total time (min)	Hands-on time (min))	Automatic KingFisher processing time (min)	Total time (min)
Sample	**AGOWA mag Maxi DNA Isolation kit**					
Fresh blood sample	20	45	65	10	37	47
	InviMag Blood DNA Mini Kit					
Fresh blood sample	10	25	35	20	33	53
	AGOWA mag DNA Isolation Sputum Kit					
Dried blood stain sample	15	32	47	5	33	38
Buccal sample	15	32	47	5	33	38
	InviMag Forensic Kit					
Dried blood stain sample	10*	23	33	10*	24	34
Buccal sample	20	24	44			
Hair sample	10*	24	34			

*Estimated time, requires overnight pre-incubation for the lysis

4.2 DNA characterization

4.2.1 Photometric DNA measurements

Photometric determinations of DNA concentrations were calculated based on the absorbance at 260 nm using 320 nm as a reference blank measurement. The DNA purity was estimated based on the absorbance ratio at 260/280 nm. The calculated absorbances are shown in Table IX.

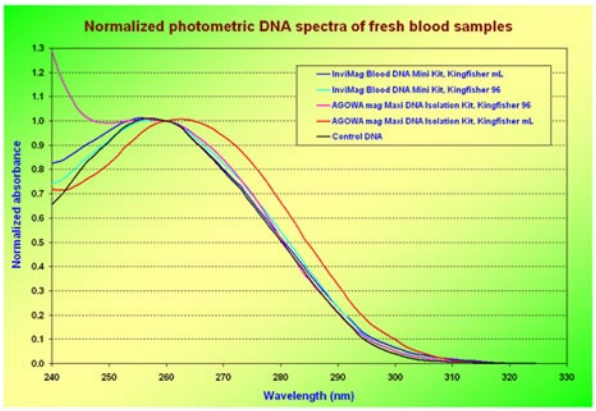
DNA spectra of the samples purified from fresh blood were determined together with the spectra of pure control DNA. Absorbance values of each spectrum at 320 nm were used as reference blanks and subtracted from the results with all other wavelengths. Then the spectra were normalized based on the 260 nm absorbance value so that the absorbance at 260 nm was set to 1.000 and all other wavelengths were calculated relative to that. The spectra estimate the quality of the purified DNA samples and are shown in Picture 1.

Table IX. Calculated DNA concentrations and yields from photometric measurements with 260 nm and 280 nm.

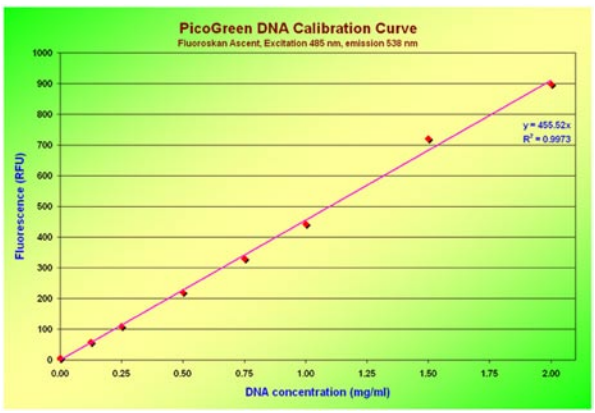
	KingFisher mL				KingFisher 96			
	n	260/280 ratio	Concentration (µg/ml)	Yield (µg/ sample)	n	260/280 ratio	Concentration (µg/ml)	Yield (µg/ sample)
Sample	**AGOWA mag Maxi DNA Isolation kit**							
Fresh blood sample	12	1.71 ± 0.11	49.7 ± 2.3	9.9 ± 0.5	4	1.82 ± 0.07	15.3 ± 2.4	3.1 ± 0.5
□								
Fresh blood sample	16	1.78 ± 0.02	31.9 ± 4.4	6.4 ± 0.9	6	1.83 ± 0.03	28.5 ± 4.7	5.7 ± 0.9
InviMag Forensic Kit								
Dried blood stain sample	11	1.51 ± 0.04	10.7 ± 1.9	1.3 ± 0.2	4	1.45 ± 0.04	21.3 ± 1.5	2.1 ± 0.1
Buccal sample	2	1.66 ± 0.06	35.1 ± 4.6	4.2 ± 0.5				
Hair sample	6	1.48 ± 0.15	14.4 ± 6.2	1.7 ± 0.7				

4.2.2 Fluorometric DNA measurements

DNA concentrations of the purified forensic samples were determined using the PicoGreen assay. Commercial, pure DNA was used to generate a calibration curve that is shown in Picture 2. Unknown sample concentrations were calculated using linear regression based on the calibration curve, and the results are shown in Table X.



Picture 1. Normalized DNA spectra of selected purification samples



Picture 2. DNA calibration curve of fluorometric PicoGreen DNA assay

Table X. Calculated DNA concentrations and yields determined with PicoGreen assay from the forensic samples purified with KingFisher instruments.

	KingFisher mL			KingFisher 96	
	n	Concentration (µg/ml)	Yield (µg/sample)	Concentration (µg/ml)	Yield (µg/sample)
Sample	**AGOWA mag Maxi DNA Isolation kit**				
Fresh blood sample	4	260.9 ± 47.2	5.22 ± 0.9	174.3 ± 56.3	3.49 ± 1.1
AGOWA mag DNA Isolation Sputum Kit					
Dried blood stain sample	2	36.7 ± 19.8	0.73 ± 0.4	91.4 ± 7.7	1.83 ± 0.2
Buccal sample	2	7.4 ± 0.2	0.15 ± 0.004	8.1 ± 0.5	0.16 ± 0.01

5 Conclusions

DNA from all the forensic samples tested was successfully purified with both KingFisher instruments. Almost identical yields were also obtained with two different instruments after optimization of the purification protocol.

DNA characterization with photometry was sometimes slightly problematic due to the strong interference of chemical traces from the purification process. For example, when blood DNA was purified with the AGOWA mag Maxi DNA Isolation Kit, there was a clear difference in DNA concentrations between photometric and fluorometric determinations, especially when the KingFisher mL instrument was used: the total yield based on the fluorometric assay was 5.2 µg, whereas the photometric assay from the same sample gave 9.9 µg. The same difference is not seen in the purifications performed with the KingFisher 96 instrument. This difference is caused by traces of acetone in the final purified DNA sample. Acetone has a strong absorbance at the area of 260-280 nm, which causes an error in the photometric determination. This same acetone effect is also seen in Picture 1, where spectra of DNA purified with the AGOWA mag Maxi DNA Isolation Kit and KingFisher mL are clearly different from all the other spectra, including the control DNA spectra. Traces of acetone clearly induce shifting of the spectral maximum towards the higher wavelengths. The same is seen from the A260/A280 ratio that clearly differs from the sample purified with KingFisher 96. KingFisher 96 works better in this purification process because it is possible to use elevated temperatures in the elution step with KingFisher 96. In the optimized protocol, elution is performed at 65°C, which increases evaporation of the acetone from the sample. As seen, when KingFisher 96 is used, photometric and fluorometric assays readily give good corresponding results and the A260/A280 ratio is clearly improved.

These results show that purification of forensic DNA samples is easily optimized to give satisfactory DNA quality and yield for any common purpose. The KingFisher 96 model's high-temperature incubator offers an extra benefit in the purification and can improve the purification results in certain purification chemistries. Measuring the DNA spectra of the purified sample with a spectral scanning photometer is a valuable asset in the evaluation of DNA quality and possible impurities in the sample. The most efficient and sensitive method for quantitative determination of DNA concentration and yield is the fluorometric PicoGreen assay because it is clearly more tolerant to interfering effects than the direct UV photometric determination. Using KingFisher magnetic particle technology is a very fast method for the purification of DNA. All samples can be purified in a time scale of 30 – 60 minutes of the total working time and manual hands-on times are limited to less than 20 min. Running the actual purification protocol with the KingFisher instrument only takes between 20 – 40 min, depending on the complexity of the purification process.

Based on all the results from this work, we can conclude the following findings:

- DNA purification can be performed with all the tested DNA purification kits with both the KingFisher instrument models giving acceptable DNA quality and yield.
- KingFisher magnetic particle technology offers both the shortest hands-on and total purification times of all common purification methods.
- The KingFisher 96 instrument model is generally slightly more convenient in the purifications because of its incubation option that can be used to decrease some impurities in the resulting DNA.
- It is more reliable to use fluorometric detection to determine DNA concentration than photometric UV measurement at 260 nm because the fluorometric assay is more tolerant to interferences.
- Photometric DNA spectra are recommended to be measured because DNA quality and efficiency of the purification process can easily be estimated based on it.
- Optimal instrument configuration for efficient DNA purification of forensic samples would be the KingFisher 96 magnetic purification processor combined either with the Fluoroskan Ascent fluorometer and Thermo's Multiskan® Spectrum spectral scanning photometer or with the Varioskan spectral scanning multimode reader.

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