Qurin
Urine-based liquid biopsy diagnostics

WHITEPAPER

Recovering high-molecular-weight DNA from full-void urine

Qatra™ Genomic DNA Extraction Lab Kit (Research Use Only)



www.qurin.com
customer.service@qurin.com

Qurin
Urine-based liquid biopsy diagnostics

The extraction challenge

Liquid biopsies offer a dynamic and minimally invasive window into cancer biology. While tissue biopsies provide a localized snapshot of a tumour, liquid biopsies can offer a broader and more dynamic view of the disease over time. This creates opportunities for (early) cancer detection, assessment of treatment response, and surveillance for recurrence.

Urine is particularly attractive as liquid biopsy because it can be collected noninvasively, repeatedly, and even at home without the involvement of a healthcare professional. Its availability also supports serial sampling and the potential for multiomics (combined analysis of multiple biological data types such as DNA, RNA, proteins and metabolites). Importantly, its potential may extend beyond cancer of the urogenital tract: small fragments of circulating cell-free DNA, including tumour-derived DNA, can cross the renal filtration barrier and enter the urine. This transrenal DNA could provide molecular information on cancers elsewhere in the body (Jordaens et al, IJC, 2023).

Unlocking the diagnostic potential of urine begins with overcoming the extraction challenge. Urine is a complex and highly variable biological matrix: its composition, volume, and pH can differ between individuals and fluctuate with collection time, hydration status, and other physiological factors. These variables can also affect biomarker concentrations, which may already be extremely low. In addition, biomarkers may degrade during collection, storage, and transport, while substances present in the sample may interfere with downstream analysis.

Inconsistent biomarker recovery can reduce analytical sensitivity and reproducibility, ultimately limiting the clinical applicability of an assay. Many conventional extraction methods are not specifically developed to address these challenges in urine-based oncology diagnostics.

www.qurin.com
customer.service@qurin.com

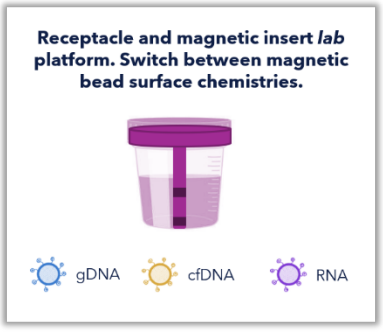
Qurin
Urine-based liquid biopsy diagnostics

Qatra™ R&D Program

Conventional extraction methods are generally designed for relatively small urine volumes, often up to 50 mL, whereas a full adult void can, on average, contain up to 400 mL. When biomarkers occur at extremely low concentrations, processing a larger volume can increase the total number of biomarkers available for recovery. However, volume alone is not sufficient: achieving consistently high recovery efficiency is equally important to maximize the analytical input for downstream testing.

Qatra R&D Program

This challenge provided the rationale for Qurin®'s vision and gave rise to the Qatra R&D Program: a modular platform for lab and at-home biomarker extraction from urine. Whether targeting genomic DNA, cell-free DNA, RNA, extracellular vesicles, proteins or other, the platform adapts to the research needs: simply switch modules (beads for laboratory workflows or cartridges for at-home collection). The Qatra platform is developed to process a full urine void of up to 400 mL and maximizes the recovery of specific biomarkers for downstream molecular analysis. The workflow is designed to support automation, scalability, and cost-efficient implementation, while facilitating seamless integration into existing laboratory workflows.



Qatra gDNA Extraction Lab Kit (RUO)

The first product resulting from Qatra R&D Program is the Qatra Genomic DNA Extraction Lab Kit (RUO), a Research Use Only solution designed to recover high-molecular-weight DNA from urine in a laboratory setting. All information presented in the remainder of this white paper pertains specifically to the Qatra gDNA Extraction Lab Kit (RUO), hereafter referred to as Qatra.

Technology review

Processing larger urine sample volumes up to 400 mL requires a different approach to capture and extract the DNA. Current commercially available standards using spin-columns or magnetic beads are optimised for up to 50 mL. For spin-columns, larger volumes are challenging as the increased amount of cell pellet and cellular debris may clog the silica membrane, substantially slowing the passage of the lysate through the column and reducing extraction efficiency. Standard 50 mL bead-based methods use an external magnet for bead retrieval. Increasing the volume by using larger cups, increases the distance to this external magnet. The reduced magnetic field may result in in slow and inefficient bead migration or even incomplete bead capture, resulting in less analyte recovery. Qatra uses two proprietary techniques (patents pending) to enable large volume sample processing.

Proprietary magnetic-bead coating, DNA capture and release (patent pending)
Qatra uses magnetic beads with a proprietary bead surface chemistry. Poly-L-lysine (PLL) is a cationic polymer at physiological pH whereas DNA is an anionic biopolymer. PLL coated magnetic beads, included in the kit, are mixed in the DNA containing urine and bind the DNA through electrostatic interaction, without centrifugation or chaotropic agents (see Figure 1).

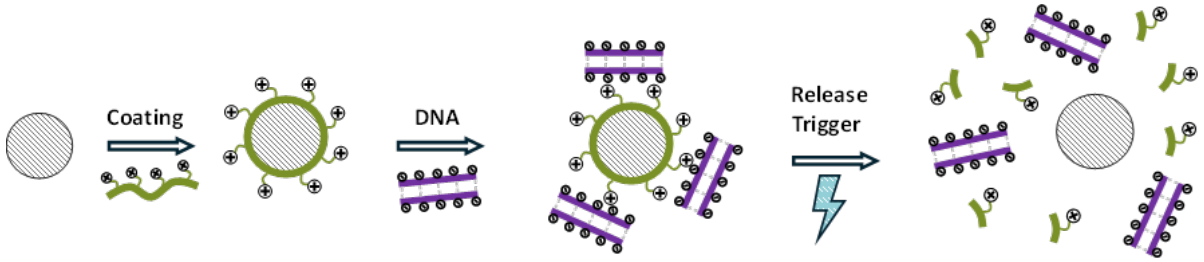


Figure 1: Capturing and releasing DNA from proprietary magnetic-bead coating.

The DNA loaded magnetic beads are dispersed in a Trypsin (enzyme) solution to release the DNA from the bead surface. Trypsin is a well-known enzyme for digesting PLL and converting it to small fragments. Consequently, no driving force remains for DNA to stay bound to the bead surface, thereby releasing the DNA in the solution (see Figure 1).

Proprietary magnetic insert for bead retrieval (patent pending)

Qatra uses a magnetic insert that is placed directly into the urine-filled receptacle (see Figure 2). The positioning of the magnets and the resulting magnetic field are optimised for the rapid and efficient retrieval of the beads from large volumes of whole urine. Once the beads have been immobilised against the tube wall surrounding the magnetic insert, the insert can simply be removed from the receptacle and transferred for manual or automated liquid handling, enabling a streamlined, largely hands-off workflow.



Figure 2: Magnetic insert components shown separately (left) and assembled in the corresponding collection receptacle (right).

Workflow stages



Collect urine directly into the provided receptacle containing preservatives. Add the coated beads according to the specified bead-to-urine ratio and incubate the beads in the urine sample to allow genomic DNA to bind to the bead surface.



Place the magnetic insert to attract and immobilize the beads carrying the bound genomic DNA. Remove the magnetic insert to separate the DNA-bound beads from the supernatant.



Wash the beads to remove residual urine components, preservatives, and other impurities. Add the elution solution to release the purified genomic DNA from the beads and collect the DNA-containing eluate.



Use the purified genomic DNA as input for downstream molecular analyses, such as DNA methylation profiling, mutation detection, SNP genotyping, or other genomic assays.

Workflow integration

The sample-processing workflow is designed to be as hands-off as possible, supporting both streamlined manual processing and automation. The individual steps are based on standard laboratory procedures and can be adapted to robotic liquid-handling platforms, such as Tecan systems, facilitating seamless integration into existing laboratory workflows. The collection receptacle is supplied with preservatives already present, allowing urine to be collected outside the laboratory environment. This enables decentralized sample collection, followed by storage and transport to the processing laboratory while minimizing DNA degradation and preserving sample integrity prior to extraction.

Qatra achieves higher DNA yields with increasing sample volumes

A pooled urine sample with unknown DNA content was prepared using donations from healthy volunteers. Following the Qatra's instructions for use, DNA was extracted in triplicate from 50, 200 and 400 mL aliquots of the pooled urine sample. When biomarkers are present at low concentrations, processing larger sample volumes can increase the total number of biomarker molecules available for recovery. This experiment was therefore designed to assess whether increasing the volume of urine processed with Qatra results in greater DNA recovery.

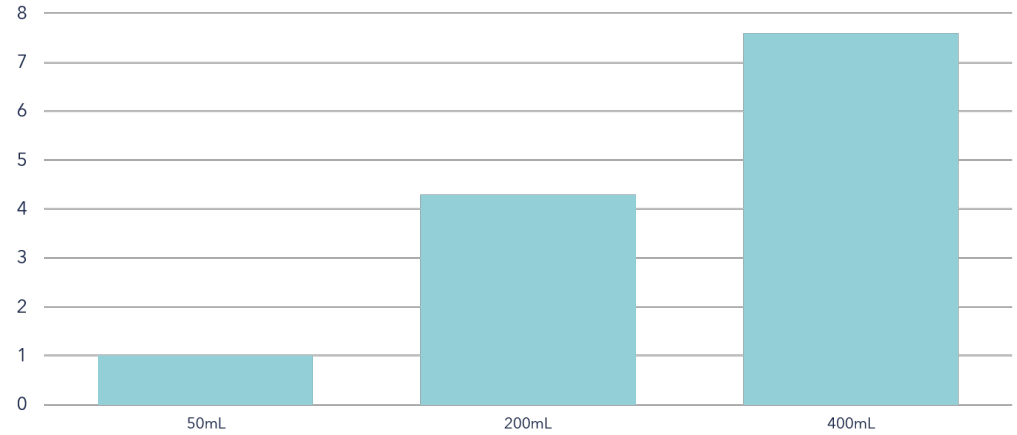


Figure 3: Qatra's DNA yield (in µg) per sample volume increase.

Figure 3 summarises the mean results of the triplicate experiments. Increasing the processed urine volume from 50 to 400 mL resulted in a 7.6-fold increase in DNA yield, closely corresponding to the 8-fold increase in sample volume. These results demonstrate that Qatra can leverage larger urine volumes to achieve a near-proportional increase in DNA recovery, which may be particularly valuable when targeting low-abundance biomarkers where maximising the amount of recoverable DNA is critical.

In addition to DNA yield, preserving DNA integrity during extraction is important for applications requiring long DNA fragments. TapeStation analysis of DNA recovered by Qatra from a pooled urine sample showed a substantial high-molecular-weight DNA population (Figure 4), indicating that long DNA fragments are retained during the extraction process.

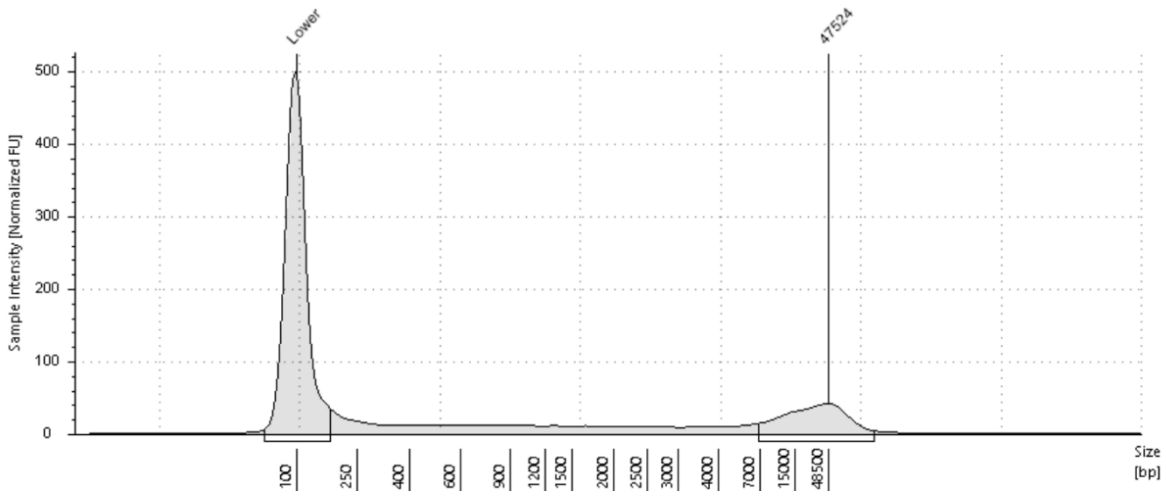


Figure 4: TapeStation gel electrophoresis showing high-molecular-weight DNA recovered from pooled urine using Qatra.

Comparative Benchmark

To assess the performance of Qatra relative to established commercially available DNA extraction methods, a comparative benchmark was performed using a 200 mL urine input volume, evaluating 5 kits in total (see Figure 5). This volume was selected to evaluate the different extraction methods under conditions relevant to large-volume urine processing.

A	B	C	D	E
Spin column-based DNA extraction kit.	Spin column-based DNA extraction kit.	Bead-based DNA extraction kit.	Bead-based DNA extraction kit.	Qatra bead-based gDNA extraction kit.

Figure 5: Overview of kits included in this comparative benchmark.

A pooled urine sample with unknown DNA content was prepared from donations from healthy volunteers and divided into 200 mL aliquots to ensure that all extraction methods were evaluated using the same starting material. Each method was performed in triplicate according to the respective manufacturer's Instructions for Use. The methods were compared across two key parameters: DNA yield and workflow efficiency.

DNA yield

Firstly, the benchmark compares DNA yield, the key measure of extraction performance, particularly when working with urine, where DNA may be present at relatively low concentrations. The ability to efficiently recover the DNA available in a large sample volume can therefore be critical for obtaining sufficient material for downstream molecular analyses. Figure 6 compares the average DNA yield obtained from 200 mL of urine using Qatra and four alternative extraction methods. Qatra achieved the highest average yield, approximately 1.8 times that of the next-highest-yielding method.

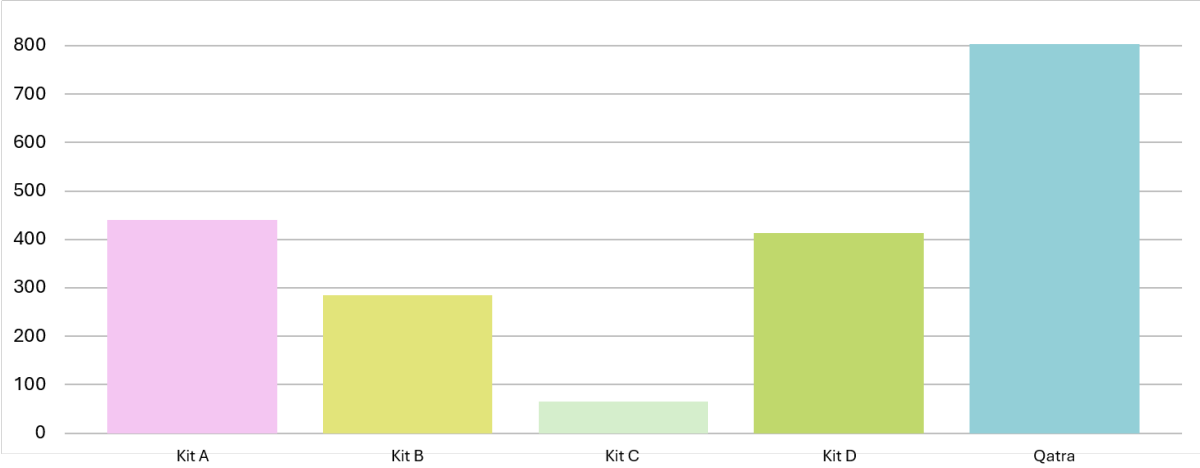


Figure 6: Comparative benchmark on DNA yield in ng on 200 mL urine samples.

Workflow efficiency

Lastly, the benchmark compares workflow efficiency (see Figure 7). To evaluate the practical workload associated with each extraction method, the total processing time was divided into hands-on time and hands-off time. Hands-on time represents steps requiring active operator involvement, such as sample handling, reagent addition, transfers, centrifugation, and washing, whereas hands-off time represents periods during which the process can proceed without operator intervention.

The shortest overall turnaround time (TAT) is 77 minutes for Kit B, followed by Qatra with 86 minutes and on a third place 95 minutes for Kit A. While Kit B does indeed lower the TAT by approximately 10% compared to Qatra, Qatra's hands on time is, with 21 minutes, almost 2-fold lower compared to Kit B (40 minutes), making the workflow more labour efficient.

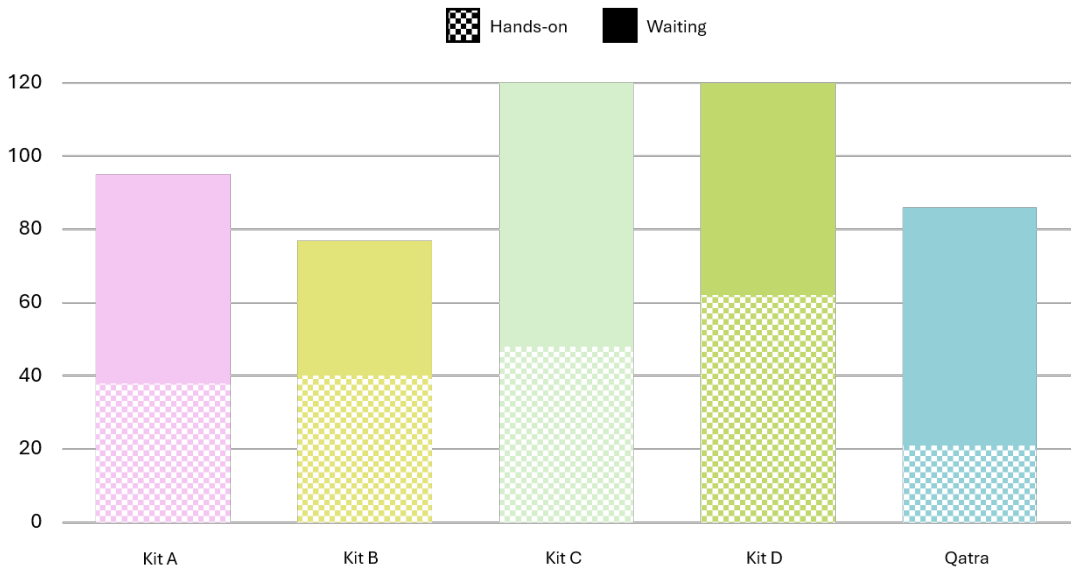


Figure 7: Comparative benchmark on workflow efficiency in hands-on and hands-off time (in minutes per extraction).

Conclusion

Across both performance pillars: DNA yield, and workflow efficiency, Qatra demonstrated strong performance in this benchmark. When processing 200 mL of urine, Qatra achieved the highest DNA yield while maintaining an efficient workflow with less hands-on operator involvement, enabling a more streamlined and largely hands-off extraction process. For applications where direct processing of large urine volumes is required, Qatra demonstrates efficient DNA recovery and practical laboratory efficiency.

It should be noted that most of the tested alternative kits in this comparison could be adapted to process a total volume of 200 mL, for example by dividing the sample into multiple smaller aliquots of 40 mL and performing separate extractions. Such an approach may improve overall DNA recovery; however, it would require multiple parallel extractions, increasing reagent consumption, cost, hands-on time, and sample handling.

Specific details on the commercially available extraction kits included in this benchmark may be disclosed upon request.

Qurin
Urine-based liquid biopsy diagnostics

Qatra in summary

Qatra is designed to address the challenges associated with extracting genomic DNA directly from large volumes of urine, supporting sample volumes ranging from conventional 50 mL laboratory volumes up to a 400 mL full void. By enabling more urine to be processed in a single extraction workflow, Qatra increases the amount of biological material available for recovery; an important advantage when targeting biomarkers present at low concentrations.

At the core of Qatra is a proprietary magnetic bead surface chemistry (patent pending) developed for efficient DNA capture from whole urine without centrifugation, combined with a proprietary magnetic retrieval system (patent pending) optimized for recovering DNA-loaded beads from large sample volumes. This approach eliminates the need to first concentrate the urine by centrifugation or divide large samples across multiple conventional extractions. The workflow is designed to be simple, scalable, and largely hands-off, with the potential for automation to further reduce operator involvement and facilitate higher-throughput processing. Importantly, large-volume capability is achieved without compromising DNA quality: in the data presented here, Qatra combined high DNA yield with high DNA integrity and favourable workflow efficiency.

Together, these features position Qatra as a large-volume urine DNA extraction platform built around four core strengths:

- scalable processing up to a full void,
- modular bead surface chemistry,
- efficient magnetic bead retrieval,
- and an automation-compatible workflow.

www.qurin.com
customer.service@qurin.com

Qurin
Urine-based liquid biopsy diagnostics

Qatra at a glance

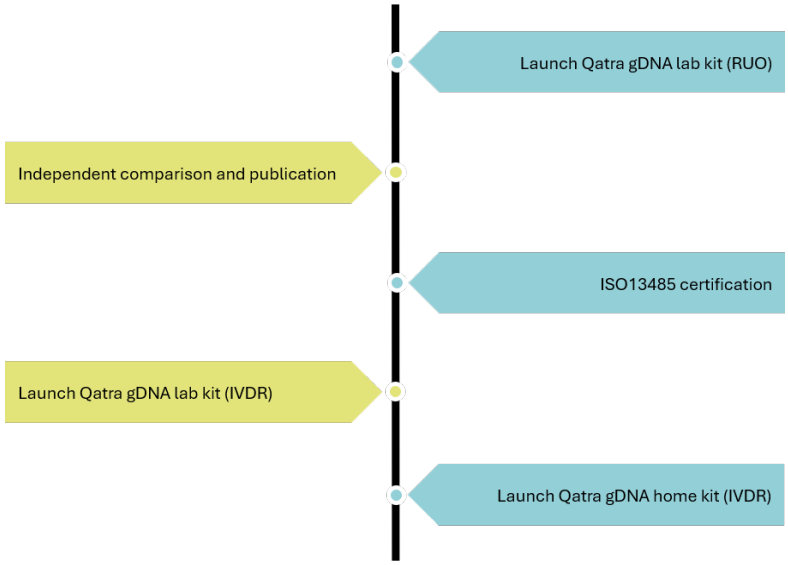
Intended sample type and urine fraction:	Human, full void, whole urine.
Optimal sample volumes:	50 – 400 mL.
Collection and preservation requirements:	Collection in the provided preservative-containing cup.
Sample transportation and storage conditions:	Transport at room temperature. Store the urine sample cooled at 2-8 ˚C.
Qatra kit transportation and storage conditions:	Transport at room temperature. Components require different storage conditions, including room temperature, refrigeration at 2–8 °C, and freezing at −20 °C.
Turnaround time:	86 minutes (21 minutes hands-on and 65 minutes waiting).
Manual or automated operation:	Both manual and automated operation are possible. Contact us for more information on automation.
Required equipment and consumables:	- Pipets 2-1000 µL; - Wide bore or cut-off tips for extraction high-molecular-weight DNA; - Vortex mixer; - Shaking platform; - Incubator up to 80 ˚C; - DNA quantification equipment (i.e. Qubit).
Resulting DNA format and storage conditions:	Tris buffer; Store at 4 ˚C short-term and -20 ˚C long-term.
Downstream gDNA application:	(q)PCR, qMSP and sequencing.

www.qurin.com
customer.service@qurin.com

Qurin
Urine-based liquid biopsy diagnostics

Development roadmap

The Qatra Genomic DNA Extraction Lab Kit (RUO) represents the current stage of an ongoing product development program and provides the foundation for further optimization and the development of next-generation solutions. The overview below outlines the planned next steps and future development direction for genomic DNA extraction within the Qatra R&D Program. For more information on developments within the broader Qatra R&D Program beyond genomic DNA extraction, please visit our website or contact us via the mail address below.



Partnerships

We are actively seeking partnerships that can accelerate innovation in urine-based diagnostics. If you are developing complementary patented - or patentable technologies for urinary biomarker extraction or diagnostic applications and are looking for development partners, we would welcome the opportunity to connect. We are equally interested in exploring how our technologies and products could enhance or complement your own. Feel free to reach out using the email address in the footer.

www.qurin.com
customer.service@qurin.com