eppendorf

APPLICATION NOTE No. 502

Sustainable Performance Without Compromise: Evaluation of Eppendorf Deepwell Plates BioBased in Molecular Biology Workflows

Estelle Deboever[1], Nathalie Chandelier[1], and Rafal Grzeskowiak[2]
[1]Eppendorf Application Technologies (EAT), [2]Eppendorf SE

Abstract

In the pursuit of sustainable innovation without performance trade-offs, Eppendorf introduces Deepwell Plates (DWPs) BioBased – engineered from ≥95% renewable feedstock via ISCC PLUS-certified mass balance. This study rigorously benchmarks the biobased DWPs against their fossil-sourced equivalents across a representative molecular biology workflow, including bacterial DNA extraction, sample storage, and quantitative PCR.
Using automated magnetic bead–based purification and high-sensitivity qPCR analysis, the plates demonstrated equivalent DNA yield, integrity, and amplification fidelity, with no detectable PCR inhibition or sample degradation. Stability tests under refrigerated and frozen conditions confirmed long-term nucleic acid preservation, while plate handling remained robust under robotic processing and centrifugation. Across all workflow stages, DWPs BioBased upheld the stringent physical, chemical, and functional requirements of high-throughput molecular biology and NGS sample prep. These findings affirm that sustainable labware can fully align with the uncompromising standards of modern research – offering a seamless drop-in alternative that supports both scientific and environmental goals.

Introduction

Lab managers care about performance. Obviously, there is a growing sense of urgency that we need to find more sustainable solutions in all aspects of our daily life. And we agree on the fact that even little things add up. In high throughput Automation (HTA) many little things can add up quickly. Yet, in validated laboratory workflows sacrificing product reliability and performance simply is not an option. Which is why we tend to look out for solutions that will offer us a path of increased sustainability while maintaining the quality level of existing ones.

Eppendorf already offers such a solution for PCR plates with the twin.tec® Trace PCR Plates BioBased*[1], contributing to greater sustainability while maintaining identical technical specifications. Upstream of the twin.tec Trace PCR plate used in HTA applications Deepwell Plates (DWPs) are indispensable formats that support a wide range of steps, from sample collection, isolation & purification to storage and downstream analysis. Their application field ranges from molecular biology and proteomics to cell culture and drug discovery.
Being part of HTA workflows they are subject to high requirements to ensure that processes are robust and reliable and that assay results are accurate, consistent and reproducible over years.

Meeting all those specifications is the high bar Eppendorf's new generation of Deepwell Plates BioBased**[1] need to meet.

*Made from min. 86 % renewable feedstock (mass-balance-approach)
**Made from min. 95 % renewable feedstock (mass-balance-approach)

Reflecting current trends, Next-Generation Sequencing (NGS) has become a standard method for microbial strain typing and diagnostics. This Application Note takes reference to the steps involved in a theoretical case of such sequencing-based approach. It evaluates the performance of Eppendorf Deepwell Plates BioBased across multiple steps by mimicking a sample preparation protocol aimed at enabling the downstream NGS analysis, including:

> Sample collection from bacterial cultures
> Magnetic bead–based nucleic acid purification
> DNA integrity assessments
> Short- and long-term storage
> Impact on subsequent PCR/qPCR analysis

The protocol analyzed here illustrates this approach using genomic bacterial DNA as a model and is outlined in Figure 1. It highlights the key stages where DWPs are employed and underscores their central role in enabling efficient, high-throughput processing.

Throughout each phase, DWPs must meet demanding requirements: robust resistance to chemicals and high centrifugation forces, reliable sealing to prevent evaporation, compatibility with robotic systems, clear labeling for traceability, and efficient sample mixing and recovery. Ensured by meticulous design and strict quality control, Eppendorf Deepwell Plates BioBased meet the exact same technical specifications as their long-established fossil-sourced counterparts. Focusing on a typical and broad set of those specifications, this Application Note demonstrates how Eppendorf's Deepwell Plates BioBased meet the same high bar of quality and performance.

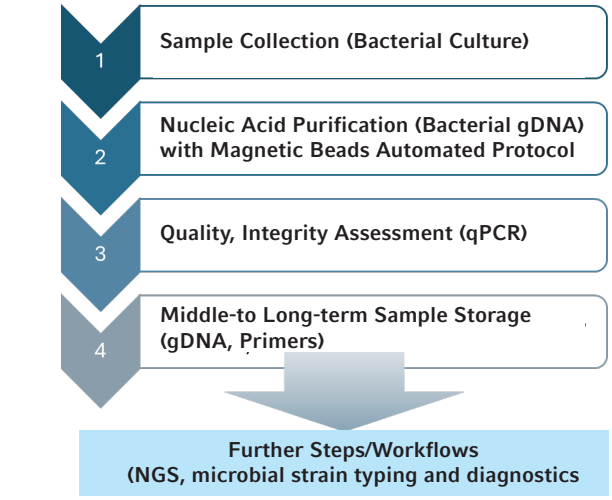


Figure 1: Molecular biology workflow in which the performance of DWP fossil-sourced and biobased was compared.

Materials and methods

All experiments were performed in triplicates and repeated in three independent runs (n = 9). The performance of 2 mL Eppendorf Deepwell Plates BioBased was benchmarked against fossil-sourced plates across key workflow stages, including bacterial culture, nucleic acid purification, sample storage, and qPCR analysis.

Automated Nucleic Acid Purification

Staphylococcus epidermidis cultures were lysed, and genomic DNA (gDNA) was purified using the Macherey-Nagel NucleoMag® DNA Bacteria Kit on the Eppendorf epMotion® 5075 liquid handling system. Lysates were processed in both Deepwell Plates BioBased and standard DWPs. DNA yield was quantified using the Qubit™ dsDNA BR Assay Kit, and integrity was evaluated by 1% agarose gel electrophoresis.

Storage Stability: gDNA and PCR Primers

gDNA from Acinetobacter baumannii and corresponding PCR primers (forward and reverse) were aliquoted into both DWP types, sealed with Eppendorf Heat Sealing Foil (175 °C for 3 seconds), and stored at 4 °C for 3 days or –20 °C for 30 days. DNA concentrations were measured by Qubit fluorometry, and primer concentrations by NanoDrop® spectrophotometry, both before and after storage. DNA integrity was assessed via gel electrophoresis, and primer functionality was validated using qPCR.

PCR Performance Validation

Quantitative PCR was performed using Takyon™ No ROX SYBR 2X MasterMix and stored S. epidermidis gDNA. Serial dilutions were run in Eppendorf twin.tec Real-Time PCR Plate 96 sealed with Eppendorf Masterclear Cap strip to generate standard curves. Quantification cycle (Cq) values were plotted against the logarithm of input copy numbers, yielding an R^2 value of 0.9998. No PCR inhibition was observed in either plate type, confirming material compatibility with sensitive enzymatic assays.

Results

Automated Nucleic Acid Purification
To evaluate the compatibility of Deepwell Plates BioBased with automated molecular biology workflows, nucleic acid purification was performed using magnetic bead–based extraction of bacterial genomic DNA (gDNA). The workflow was designed to reflect common NGS sample preparation protocols used in microbial typing and diagnostic applications.

The DWPs – both biobased and fossil-sourced Eppendorf reference plates – were initially used for bacterial culture, pelleting, and lysis (data not shown). Subsequently, the DWPs were filled with bacterial lysates and processed in parallel using magnetic bead–based chemistry. The entire procedure was conducted in a fully automated workflow. Throughout the process, the biobased plates demonstrated excellent mechanical integrity, including:

> Reliable grip handling by robotic systems
> Stability under various transport and centrifugation conditions
> Dual-color coding for step-specific traceability

The extracted gDNA was assessed for yield and integrity. Quantification results (Figure 2) indicated no statistically significant differences in DNA concentration between plate types across all replicates. Furthermore, gel electrophoresis analysis (Figure 3) confirmed consistent, high-quality gDNA band patterns for both materials, supporting equivalent nucleic acid integrity and absence of sample degradation. Notably, all biobased DWPs used in this workflow were certified PCR clean and protein-free, making them suitable for both DNA- and protein-focused downstream applications.

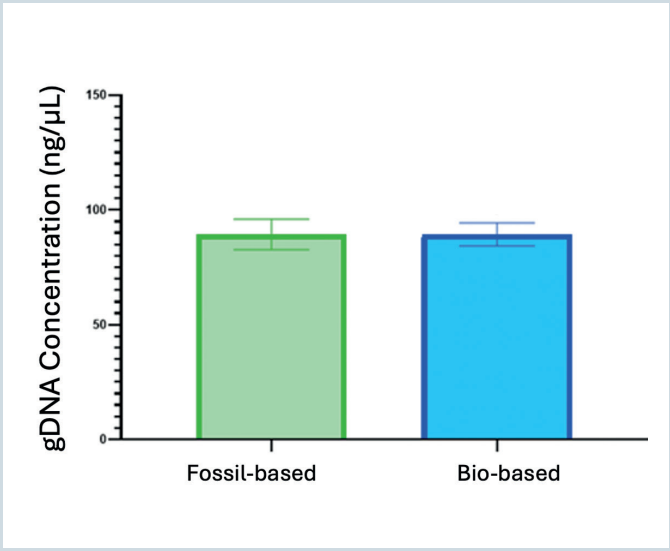


Figure 2: Bar graph of the gDNA concentration obtained in the automated magnetic bead purification protocol using standard and DWPs BioBased. Identical gDNA concentrations were observed (n=9).

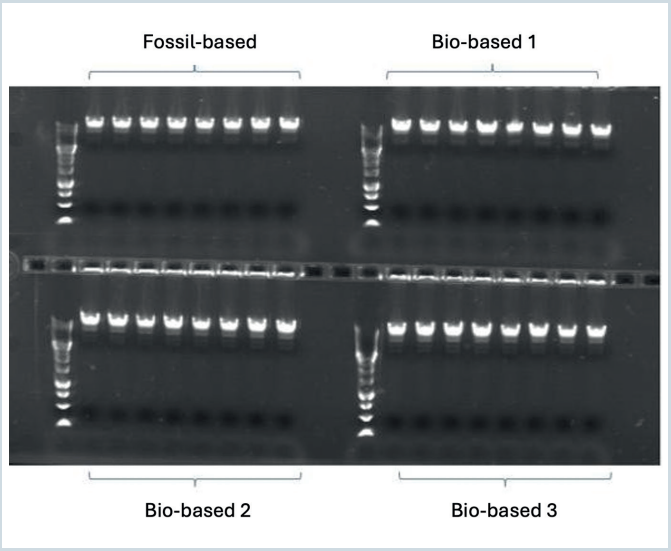


Figure 3: Gel electrophoresis analysis gDNA purified using biobased (Plate 1-3) and fossil-sourced Deepwell Plates. Consistent band patterns were observed across all tested conditions, demonstrating equivalent DNA yield and integrity from both plate types.

Storage Stability: gDNA and PCR Primers

To assess the suitability of Eppendorf Deepwell Plates (DWPs) BioBased for nucleic acid storage in molecular biology workflows, we evaluated the stability of both bacterial genomic DNA (gDNA) and PCR primers under typical laboratory storage conditions. Plates were sealed with Heat-Sealing Films and stored either at 4 °C for 3 days or at –20 °C for 30 days – conditions representative of routine short- and long-term sample preservation.

Quantitative analysis of gDNA using Qubit fluorometry revealed no significant difference in DNA concentration following one month of frozen storage (Figure 4), confirming that the DWPs BioBased effectively preserve nucleic acid integrity under deep-freeze conditions.

In parallel, the stability of PCR primers was assessed via UV absorbance on a NanoDrop spectrophotometer. As shown in Figure 5, primer concentrations remained unchanged after 30 days at –20 °C, indicating no detectable degradation of oligonucleotides. Identical results were obtained for primers stored at 4 °C for 3 days (data not shown), further supporting the reliability of the plates for short-term refrigerated storage.

Throughout the study, no physical deformation or sealing failures were observed – regardless of storage temperature – demonstrating the mechanical and chemical resilience of the DWPs BioBased during handling and temperature stress.

Together, these results validate the use of DWPs BioBased for secure and stable storage of nucleic acids, even over extended periods. This is especially critical in molecular biology and NGS workflows, where sample integrity, reproducibility, and container reliability are essential. By maintaining performance across storage, analysis, and downstream applications, DWPs BioBased enable seamless integration into full-cycle experimental workflow.

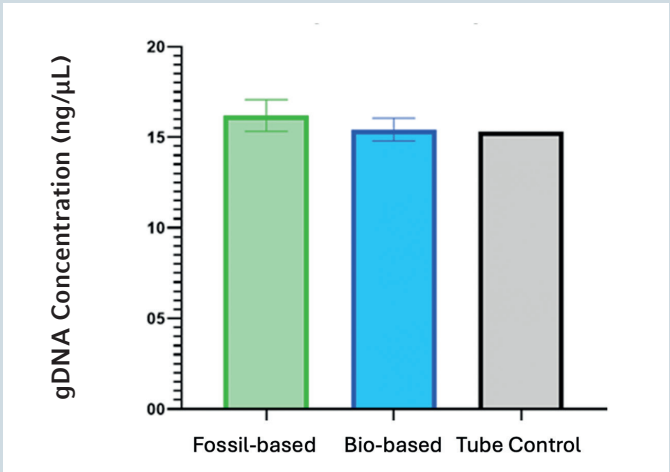


Figure 4: Bar graph of bacterial gDNA concentration measured after storage for 1 month at -20°C in fossil-sourced and DWPs BioBased (n=9). There was no significant change in gDNA concentration levels after one month of storage at -20°C across all tested conditions. Tube Control: the stock solution of the gDNA (n=1).

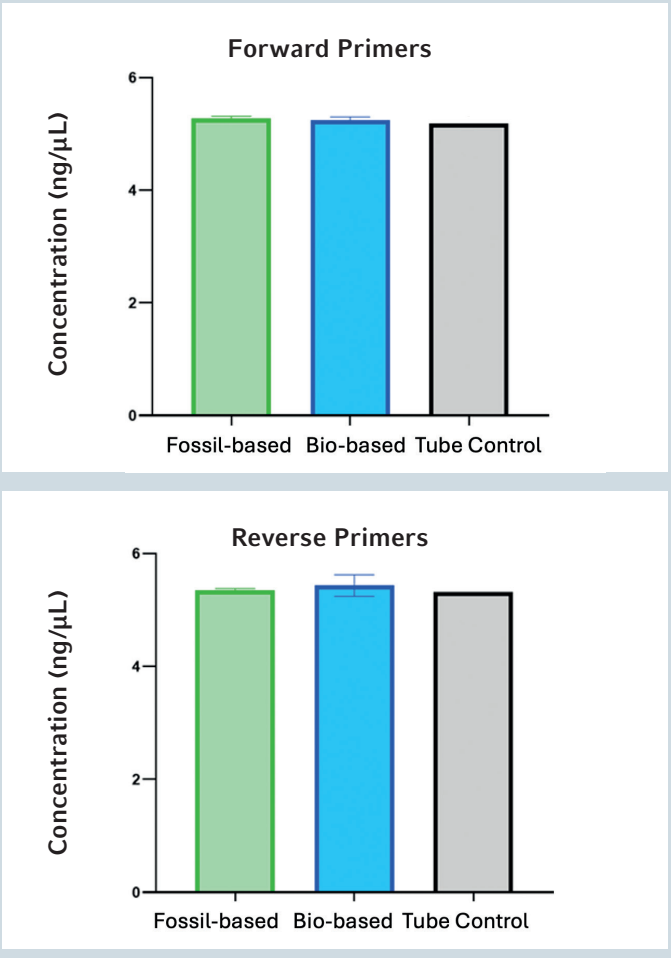


Figure 5: Quantification of PCR forward and reverse primers after storage at –20 °C for 1 month in fossil-sourced and DWPs BioBased. Primer concentrations were measured using UV absorbance on a NanoDrop spectrophotometer following storage (n=9). No significant differences were observed between fossil-sourced and DWPs BioBased, indicating that both plate types effectively preserve oligonucleotide integrity under frozen storage conditions. Tube Control: the stock solution of the primer (n=1).

PCR Performance Validation

Substances potentially leaching from DWP materials can have adverse effects on downstream applications. This is especially relevant because DWPs are typically used in workflows where stored samples are later subjected to sensitive enzymatic assays such as PCR. A common concern is the partial inhibition of amplification reactions due to material-derived contaminants.

To assess whether Eppendorf Deepwell Plates BioBased are suitable for such downstream applications, a post-storage validation was performed using quantitative real-time PCR (qPCR). Importantly, PCR reactions were not carried out directly in the DWPs; instead, DNA extracted and stored in both biobased and fossil-sourced plates was subsequently analyzed in dedicated PCR vessels. This reflects typical molecular workflows, where amplification is carried out in specialized low-binding or thin-walled PCR plates.

As shown in Figure 6A, amplification curves from a representative replicate demonstrated robust, exponential kinetics with high reproducibility – indicating that no inhibitory substances leached from the plates into the stored samples.

In Figure 6B, a dilution series of bacterial gDNA was used to construct a standard curve, plotting quantification cycle (Cq) values against log-transformed input copy numbers. The resulting regression yielded an R^2 value of 0.9998, confirming exceptional qPCR efficiency and linearity across a broad dynamic range.

These results validate not only the upstream DNA extraction and storage workflow, but also the compatibility of biobased DWPs with sensitive downstream enzymatic reactions. No PCR inhibition was observed in samples handled using either the biobased or fossil-sourced plates, underscoring the chemical inertness and purity of the biobased polypropylene formulation.

Taken together, these findings demonstrate that Eppendorf Deepwell Plates BioBased are fully compatible with downstream amplification workflows – making them a reliable and sustainable choice for molecular biology applications, including NGS sample prep, gene expression profiling, and clinical diagnostics.

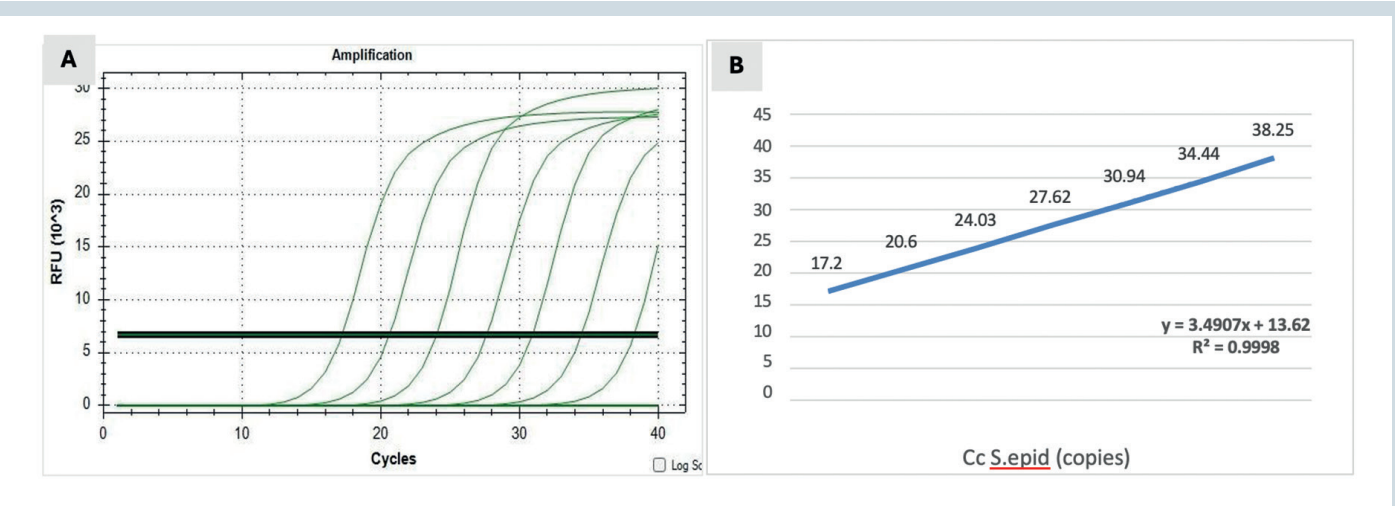


Figure 6: Quantitative PCR (qPCR) analysis of bacterial gDNA using biobased DWPs.
A) Representative amplification spectra obtained from a single replicate demonstrate consistent and robust amplification across all sample dilutions, confirming the suitability of biobased DWPs for sensitive downstream molecular applications such as qPCR.

B) Standard curve generated from a serial dilution of bacterial gDNA, with quantification cycle (Cq) values plotted against the logarithm of input copy number. The resulting linear regression indicates high efficiency and accurate quantification, reflecting excellent DNA integrity following extraction and storage in biobased DWPs (n=1).

Conclusion

This study clearly demonstrates that Eppendorf's Deepwell Plates (DWPs) BioBased*[1] match the trusted performance of their fossil-sourced counterparts – across the different critical steps of molecular biology workflows. Whether in automated nucleic acid purification, sample storage, or sensitive qPCR analysis, biobased DWPs consistently delivered outstanding **mechanical robustness, chemical resistance**, and **sample protection**.
Extensive validation – through fluorometric quantification, gel electrophoresis, and real-time PCR – confirmed high **DNA recovery, reliable amplification**, and **long-term nucleic acid stability**. Notably, there was no sign of PCR inhibition, plate deformation, or sample material degradation, even under stringent workflow conditions. This underscores the full compatibility of the Eppendorf Deepwell Plates BioBased with demanding applications, including automated **Next-Generation Sequencing (NGS)** sample preparation. By uniting **proven scientific reliability with ISCC PLUS-certified renewable materials**, Eppendorf's biobased DWPs enable researchers to make a tangible step toward sustainability – without sacrificing performance. They offer a future-ready solution for laboratories seeking to combine **environmental responsibility with data quality, efficiency, and workflow confidence.**

*Made from min. 95 % renewable feedstock (mass-balance-approach)
[1]For more information visit eppendorf.link/biobased

Your local distributor: www.eppendorf.com/contact
Eppendorf SE · 22339 Hamburg · Germany
eppendorf@eppendorf.com · www.eppendorf.com

www.eppendorf.com

NucleoMag® is a registered trademark of Macherey-Nagel, Germany. Qubit™ is a trademark of Thermo Fisher Scientific Inc., USA.
NanoDrop™ is a registered trademark of NanoDrop Technologies Inc., USA. Takyon® is a registered trademark of Kaneka Eurogentec S.A., Belgium
Eppendorf®, the Eppendorf Brand Design, twin.tec®, and epMotion® are registered trademarks of Eppendorf SE, Hamburg, Germany.
All rights reserved, including graphics and images. Copyright © 2025 by Eppendorf SE. EN1/0925
Eppendorf SE reserves the right to modify its products and services at any time. This application note is subject to change without notice. Although prepared to ensure accuracy, Eppendorf SE assumes no liability for errors, or for any damages resulting from the application or use of this information. Viewing the application note alone cannot as such provide for or replace reading and respecting the current version of the operating manual.