Final report: Making UZH a real-world laboratory for climate change mitigation

Project: *Reusing Plastic Disposables: Automated Pipette Tip Washing as a Showcase at UZH for More Sustainable and Cost-Efficient Laboratory Work*

General information

Project title	***Reusing Plastic Disposables: Automated Pipette Tip Washing as a Showcase at UZH for More Sustainable and Cost-Efficient Laboratory Work***
Short title or acronym	***TipWash***
Project start and duration	*October 1st, 2023– June 30th, 2024 (9 months including extension)*
Funding line	*Fast track project*
Funding received under this call (CHF)	*10'000*
Co-funding (if any, CHF)	*12'400 Co-funding by IPMB by June 30th, 2024. To date ca. CHF 167'500 from MNF and IPMB*
Project team	*Frachon, Léa (ISEB), Gagliardini, Valeria (IPMB), Keller, Barbara (ISEB, Schöb, Hanspeter (IPMB), Stirnemann, Marina (IPMB), Stransfeld, Lena (IPMB)*
Contact	*Schöb, Hanspeter (IPMB)*

Project description

Goals:

The project TipWash aims at pioneering automated washing of plastic disposables in Switzerland by evaluating pipette tip washing using the Grenova TipNovus© device under UZH-specific conditions. TipWash addresses aspects of useability, biosafety and sustainability under real-world lab conditions, to provide seminal expertise for an eventual upscaling of reusing plastic disposables in Swiss laboratory research, and to extend it to different types of plastic disposables. Our objectives at the start of TipWash were threefold:

1. *Formal certification of automated pipette tip washing using the Grenova TipNovus© device by the "Amt für Abfall, Wasser, Energie und Luft" (AWEL) of the canton Zurich.*

2. *An UZH-internal validation of automated pipette tip washing using the Grenova TipNovus© device as an in-house scientific basis for broader use, both in terms of upscaling and diversification.*

3. *Practical hands-on knowledge on new workflows compatible with pipette tip washing for other units at UZH that are interested in adopting such technology.*

Today, we have to state that none of the objectives stipulated above was achieved, due to very extensive demands by the AWEL to prove the safety and legal conformity of the device in the frame of objective 1, before even formally being allowed to use it for experimentation for objectives 2 and 3. The experiments requested clearly exceeded the timeframe of the only partly dedicated staff, as well as the financial scope of the Real World Laboratory grant TipWash. Thus, the project leadership has readjusted to the following new objectives that reach beyond the duration and initial goals of TipWash:

4. *Define and execute a clearcut project plan for a legally conforming operation together with the section Biosafety of the AWEL.*

5. *Gather more funds for TipWash and continue the project with hired staff beyond the frame of the Real World Laboratory grant TipWash.*

6. *Recruit a dedicated postdoc to complete the initial objectives of TipWash in collaboration with the initial partners of TipWash and to elaborate a clean documentation including a thorough energy assessment and the expected savings in CHF and CO_2 equivalents to serve in informing UZH stakeholders and others on implementation of such technologies.*

Progress:

<u>Objective 4: Satisfaction of biosafety requests</u>

TIpWash has experienced broad support, the entire funds spoken in the frame of TipWash were more than matched in cash by the leadership of the Department of Plant and Microbial Biology (IPMB) that also contributed all of the consumables costs used during TipWash. With these funds a postdoc was hired at 40% for five months to elaborate a research plan together with representatives from AWEL. The AWEL showed clear interest in supporting the project with their expertise to devise a detailed research plan that, if successful, would lead to permission to use the device under the tested conditions.

The relevant Swiss federal regulations demand that no genetically modified organisms are released into the environment, the environment starting at the drain where the tip washing device is releasing its wastewater. The definition of 'organism' includes not only living cells, but also naked nucleic acids (RNA and DNA), since naked nucleic acids can already be infectious, as is the case for many viral diseases of plants. Importantly, 'no release' does not mean zero, but a reduction by a factor 10^6 by the washing process. Hence, the principle of the research plan

elaborated with the AWEL is to overload the tip washing device with a known, large amount of genetically modified bacteria or linearized plasmid DNA, and to quantify residual amounts persisting during the washing process. Grenova, the supplier of the tip washing device, suggested the addition of diluted bleach to the first step in the tip washing procedure, to inactivate genetically modified organisms. Towards understanding the effects of bleach on the integrity of DNA we performed pilot experiments incubating a commercially available DNA ladder with different concentrations of bleach (Figure 1).

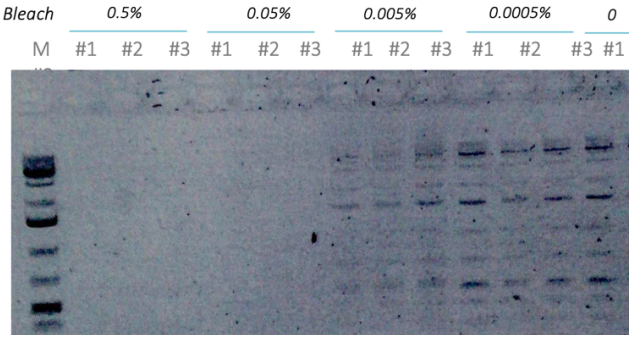


Figure 1: Effect of bleach on the persistence of DNA. 1ug of ladder DNA was incubated in triplicates in different dilutions of NaOCl at room temperature for 60 mins and then separated on a 1% agarose gel.

This experiment shows that DNA is highly unstable in the presence of even low concentrations of bleach. Time course experiments show that the disappearance is very rapid; marker DNA disappears within seconds upon contact with bleach. How the DNA disappears was not tested experimentally but experiments by others (ref) suggest that the DNA is broken down by phosphodiester-backbone breakage, deamination and depurination, efficiently rendering it biologically inactive.

In a second set of experiments, we tested the effect of Grenoclean on the persistence of DNA. Grenoclean is a company supplied detergent with a secret composition that is suggested to be added to the tip washing process. Figure 2 shows DNA ladder stability measurements in the presence or absence of Grenoclean at the concentration suggested to be used in the washing process.

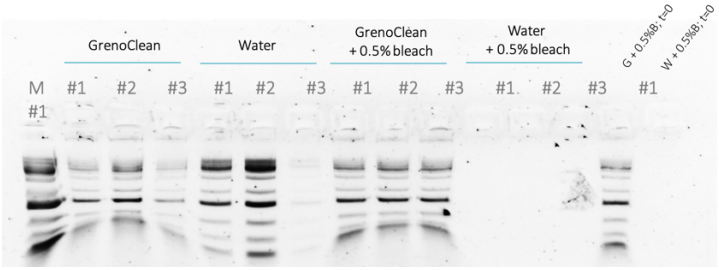


Figure 2: Effect of bleach and Grenoclean on the persistence of DNA. 1ug of ladder DNA was incubated in triplicates in different dilutions of NaOCl with or without Grenoclean at room temperature for 60 mins and then separated on a 1% agarose gel.

Interestingly, the detergent Grenoclean seemed to inhibit the destructive effect of bleach on DNA, as no degradation of DNA was found when combining bleach and Grenoclean. Hence, the two components must be applied separately during the tip washing procedure.

Based on these two key findings, the technical option of the device to fractionate the wastewater, the TipWash project team has assembled a project plan in collaboration with the AWEL to measure the persistence of genetically modified organisms during the washing process (Figure 3).

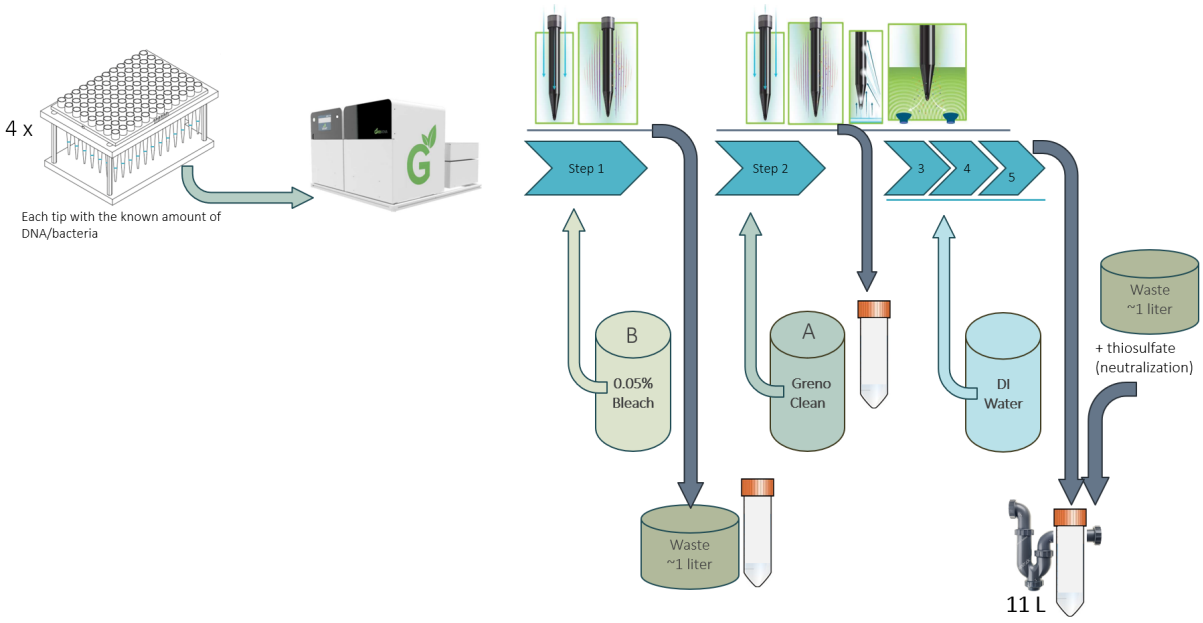


Figure 3. Overview of the tip washing process with the Grenova TipNovus device showing the different steps of the washing program, the addition of bleach, Grenoclean and deionized (DI) water, as well as applications of pressured air, sonication, UV-light and rinsing to the tips. Sample collection points are marked with a test tube.

In short, the tips will be prerinsed in diluted bleach, and the resulting contaminated wastewater from this first step will be retained separately. This fraction will be neutralized with sodium thiosulfate prior to discarding into the public wastewater system. Based on initial experiments we expect this first wastewater fraction to already show a reduction in genetically modified organisms by a factor higher than 10^6, which would allow us to pour all wastewater from the subsequent washing steps directly down the drain without any further treatment.

<u>Objectives 5 & 6: Acquisition of additional funding and continuation of the project</u>
Execution of the experimental plan to achieve legal conformity of operation of the device requires a full-time engagement of several months. To achieve this and to reach the initial goals of TipWash, the project leadership could convince the Faculty of Science of UZH to support a one-year hiring of a postdoc with CHF 145'000. Further support comes fromIPMB that continues to support TipWash by separately funding the project leadership on an hourly basis for their efforts. Another important source of support comes from the section "Engineering und Ausstattung" of the Department "Bauprojektmanagement" that will measure possible energy consumption benefits of tip washing, compared to the conventional procedures. In February 2025, a new postdoc with specialization in garbage valorisation started a one-year engagement to continue TipWash, supervised by Drs. Célia Baroux and Hanspeter Schöb.

Achieved impact in terms of GHG emissions (in t CO_2e) and co-benefits

So far zero.

Upscaling activities inside and outside UZH

The project leadership plans to comprehensively summarize its results to make it accessible for further use inside and outside of UZH, possibly complemented by technical advance publication. Towards this, we are in contact with the University of Lausanne and the EPFL that also aim at implementing tip washing in their institutions but are in a much earlier stage of implementation than UZH is.

Transdisciplinarity

As organisational aspects of laboratories such as supply management are typically handled by Technical Assistants and Laboratory Managers, an intense collaboration between them and the involved scientists was foreseen, particularly for objective 3. However, since work flows for implementation of pipette tip washing could not yet be addressed, much of this collaboration was limited to the evaluation of suitable tip box systems that are needed to tackle objective 6. We expect this part of the project to gain momentum as soon as legal clearance of device usage is completed.

Another interesting aspect is the assessment of possible energy consumption benefits of tip washing, compared to the conventional procedures. In the course of TipWash we were able to secure support by the unit "Engineering und Ausstattung" of the Department "Bauprojektmanagement". Their technical expertise and equipment will allow accurate energy consumption measurements that will serve as a basis for the energy assessments proposed in objective 6.

Lessons learned

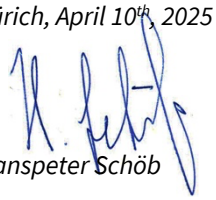
A major lesson learned is that the implementation of new technology platforms as proposed by TipWash is challenging as a side project in a bottom-up fashion. Both the scientists and the technical staff lack the possibility to dedicate more than just a few hours to such side aspects, and hence dedicated staff with an alimented mandate is needed to push forward projects like TipWash. We think that such technologies should be evaluated top-down, e.g. by the unit "Strategische Forschungsplattformen" of UZH.

Open science

This will depend on the results and on the practical experience made with tip washing in daily lab routine.

Date and signature

Zürich, April 10th, 2025



Hanspeter Schöb