Water screening

using a LabToGo system

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Miniaturized all-in-one laboratory of the future.

The viral aspect of open-source developments in analytical chemistry is evident, giving to the community innovative tools to be included in laboratories and enabling small teams to generate progress in tailored research areas or cutting-edge sience, in which commercial mainstream solutions are of no use. Open-source developments are similar to radical chain reactions, exponential in progress and highly dynamic in its result. It is an interesting experiment worth to contribute, as completely unusual or novel ideas can be pursued.

Open-source development

Open-source developments are freely available, the source code is open and modifications of the device are possible. During self-assembly, the user gains valuable troubleshooting and customization skills. Open-source hard- and software solutions come along with a steep learning curve, whereby basic knowledge on electronics, mechanics and programming is helpful. In the Office Chromatography (OC) concept, all steps of planar chromatography are miniaturized using new technologies [1] (Fig. 1). The initial approach was based on low-cost thermal inkjet printers that were slimmed down and slightly modified for operation in chromatography [1-3]. The following system generations were based on open-source technologies. The OCLab1 and OCLab2 were programmed in R and restricted in the solvent selection [4, 5]. The latest OCLab3 was newly developed as a fully solvent-resistant open-source system operated via the OCManager3 software in Python to provide a convenient graphical user interface [6]. The codes of software and firmware are freely available at https://github.com/OfficeChromatography/OCManager3 as well as the 3D print files for instrumental setup https://github.com/OfficeChromatography/OCLab3. OCLab3 is compact (26 cm x 31 cm x 34 cm), lightweight (<5 kg), and affordable (€ 1200–2300, depending on the needs). Miniaturization of all planar chromatographic steps led to a lean all-in-one LabToGo system, supporting method greenness (eco-friendliness).

Quality checks via 3D-print-based open-source chromatography system

Sample application, development and UV/Vis/FLD imaging using the OCLab3 were recently shown for screening of water samples (Fig. 2 [7]). These were directly applied without the least sample preparation but sedimentation. The application of 40 µL of the sample is sufficient. For landfill leachate samples or biogas plant water, dark zones were observed. In contrast, for the wastewater treatment plant effluent or tap water samples, almost no zone was detected. The *A. fischeri* bioassay frequently used as *in vitro* "toxicity" assay in the environmental field was used for non-targeted detection. However, it was applied as a planar on-surface bioassay. If there is almost no zone detected, it proves the water to be free of bioactive compounds which influence the energy metabolism of the bioluminescent bacteria. This is typically the case for drinking water when 40 µL are applied and this volume can be used for water sceening. Here the double volume (80 µL) was applied to verify the results for the samples showing no activity. Comparing the patterns or profiles, results are easily understood globally: no response (more pure water) is better than heavy response, evident as dark zones.

Currently, the derivatization [2] and planar bioassay application [1] are integrated and further optimizations are performed. The printing of the layer was already shown [8] to open new perspectives for layer materials and patterns and could be integrated in the future. However, also the performance of novel ultrathin layer developments in research can be analyzed by such a LabToGo system [1]. On reduced layer thicknesses, reduced solvent volumes are needed for the separation or derivatization, which will make the method even more eco-friendly and attractive.

Conclusion

As awareness on healthy food increases, so does citizens' interest in an easy-to-understand tool for checking food quality. OCLab3 combines sample application, chromatography development and imaging in an open-source, cheap, light and small apparatus. An image is worth a thousand words. By mapping and comparing patterns or profiles, results are understood across languages and globally. Artificial intelligence may assist in the future. 3D-

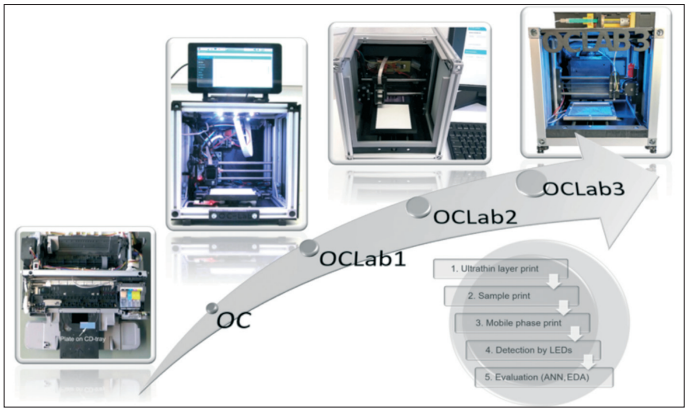

Fig. 1: Miniaturization of all planar chromatographic steps to an all-in-one LabToGo system: initially based on low-cost thermal inkjet printers that were slimmed down and slightly modified for operation in chromatography, the following generations were based on open-source technologies. First LabToGo systems were solvent-restricted and operated in R, whereas the latest was developed in Python to a fully solvent-resistant open-source system.

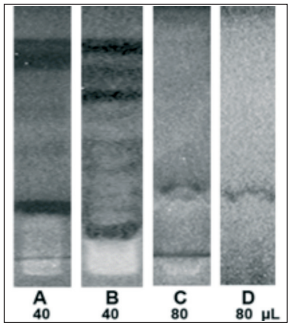

Fig. 2: OCLab 3 profiling of water: (A) landfill leachate sample with EtOAc - MeOH (2:1, V/V), (B) biogas plant water with EtOAc - Tol - MeOH - H_2O (65:20:11:/4, V/V); (C) wastewater treatment plant effluent with EtAc - Tol (9:1, V/V), (D) tap water with EtOAc - Tol - MeOH - H_2O (60:30:7:3, V/V), all after double-focusing of the applied area (40 µL or 80 µL) with acetone - water (1:1, V/V), detection with *A. fischeri* bioassay (here using the BioLuminizer). Note that no sample preparation but sedimentation was performed.

printing became more and more accessible to the public and there is a big community. We hope to inspire participation and to see that chromatography systems follow the same trend in becoming more accessible to the public. As technology and software become more available, more citizens can engage in the community, making development self-reinforcing.

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