

**EBF Young Scientists**

# Future-proofing Bioanalysis – Contributing to a sustainable world

# Sustainability in Bioanalysis

Sustainability of regulated bioanalysis was defined as stimulating or applying the 3Rs:

**Replacement, Reduction and Refinement,**  
the 6Rs:

**Rethink, Refuse, Reduce, Reuse, Recycle, Replace**  
and/or principles of green lab/chemistry

## Useful articles

**Green Bioanalytical Chemistry: A Review**, by Popat, R., Adhao, V., Thenge, R., Ajmire, P., Barde, L., Mahajan, N., JCPR 6 (2), 2016, 1809-1824. DOI: 10.33786/JCPR.2016.v06i02.002 <https://e-currentscience.com/journal/e/JCPR/archivefulldetail/544>

**Can Laboratories Move Away from Single-Use Plastic?** By Howes, L., ACS Cent. Sci. 2019 5 (12), 1904-1906, DOI: 10.1021/acscentsci.9b01249 <https://pubs.acs.org/doi/10.1021/acscentsci.9b01249>

**Sustainable and Eco-Friendly Alternatives for Liquid Chromatographic Analysis**, by Olives, A., González-Ruiz, V., Martín, M., ACS Sustainable Chem. Eng. 2017 5 (7), 5618-5634, DOI: 10.1021/acssuschemeng.7b01012 [https://www.researchgate.net/publication/317343019\\_Sustainable\\_and\\_Eco-Friendly\\_Alternatives\\_for\\_Liquid\\_Chromatographic\\_Analysis](https://www.researchgate.net/publication/317343019_Sustainable_and_Eco-Friendly_Alternatives_for_Liquid_Chromatographic_Analysis)

**Strategic focus on 3R principles reveals major reductions in the use of animals in pharmaceutical toxicity testing**, by Törnqvist, E., Annas, A., Granath, B., Jalkestén, E., Cotgreave, I., Öberg, M., PLoS One. 2014; 9(7):e101638. DOI: 10.1371/journal.pone.0101638 <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0101638>

**Opinion: Microdosing: Safer clinical trials and fewer animal tests**, by Langley, G., Farnaud, S., Bioanalysis 2 (3), 2010, DOI: 10.4155/bio.09.168 <https://www.future-science.com/doi/10.4155/bio.09.168>

## **In your opinion is sustainable regulated bioanalysis possible? (Yes / No)**

- “No due to single use consumables.”
- “In my opinion I don’t believe complete sustainability is possible. This is due to the large amount of single use plastic within a bioanalysis laboratory. The plastic e.g. pipette tips need to be both sterile before use and sterilized/incinerated post use due to the risk of blood borne viruses etc. However, I do believe the bioanalysis community could become more sustainable than it currently is.”

## **In your opinion is sustainable regulated bioanalysis possible? (Yes / No)**

- “Yes, in theory. But overcoming and reusing the gratuitous amounts of plastic consumed in the process of bioanalysis. Without risks of chemical or biological contamination.”
- “Yes, but with restrictions. Sometimes it is not possible to be sustainable without risking the scientific outcome – e.g. in cell culture assays it is not really possible to use less single use equipment/consumables and a lot of plastic waste is generated.”

## **In your opinion is sustainable regulated bioanalysis possible? (Yes / No)**

- “Yes, we should all work hard so that bioanalysis can be increasingly sustainable.”
- “I really think so. The purpose of research has always been to improve many aspects of human life. Doing it in a sustainable way increases the value of this work making the researcher honoured to contribute to the concrete improvement of a community.”

## **In your opinion is sustainable regulated bioanalysis possible? (Yes / No)**

- Majority agreed it is possible but acknowledge some concerns/restrictions
- Most notably;
  - Single use materials (e.g. pipette tips) for sterility
  - Items contaminated with hazardous waste require disposal
  - Issues with recycling/re-using solvents
  - New technology too expensive / time intensive
  - Regulatory guidance can be a restriction
- Some believe sustainable bioanalysis will increase the value of the work and give a sense of honour to give back to the community – something for us all to strive for?

## **Within your team have there been discussions of investing resources to improve sustainability?**

- “Unfortunately no.”
- “Not really, although I am aware of individuals within the business promoting sustainability and introducing practices to achieve this.”
- “Not specifically. As a company we are encouraged to recycle wherever possible both in and outside the lab. However, specifically we have not had discussions surrounding sustainability within my team.”



## **Within your team have there been discussions of investing resources to improve sustainability?**

- “Yes, in our team we always aim and strive to achieve the highest level of sustainability in our work, in particular through the use of microsampling and miniaturized pre-treatment procedures.”
- “Yes, our team is actually investing in approaches that aim to reduce the use of materials such as solvents, reagents, sample volumes and consumables. In addition, sample pre-treatment steps are reduced, saving time and energy for operators.”

## **Within your team have there been discussions of investing resources to improve sustainability?**

- Predominantly yes, either directly in a team or indirectly via other colleagues or the company themselves
- Discussions to improve sustainability commonly take the form of reducing sample volumes, miniaturised workflows and reduction and/or recycling of waste
- Implementation of discussion forums representing the company
- Validation of lower temperatures for  $-80^{\circ}\text{C}$  freezers ( $-65^{\circ}\text{C}$ )

## Have you seen a difference in efficiency/productivity since the pandemic, how do you think it has affected sustainability in your lab?

- “No differences observed.”
- “Most experiments have frozen, so the footprint of the lab is very low and productivity was reduced due to the conditions.”
- “Unfortunately the number of people who can work in the lab has been reduced since the pandemic and this has led to a reduction in productivity.”

## Have you seen a difference in efficiency/productivity since the pandemic, how do you think it has affected sustainability in your lab?

- “The unfortunate experience of the pandemic, lockdown and remote work has inevitably forced the revision of numerous lab protocols but also of simple habits. While this led to considerable inconvenience, on the other hand it was an opportunity to improve and optimize protocols, workflows and habits that were taken for granted because "it has always been done this way". The current situation represents an important opportunity to review, and improve all possible sources of waste (of time, resources, efforts and money) through the modernization, and sometimes the simplification, of even basic behaviours.”

# Have you seen a difference in efficiency/productivity since the pandemic, how do you think it has affected sustainability in your lab?

- “Surely COVID has changed the way we work by forcing us to meticulously plan our research in order to avoid overcrowded labs and consequently made us more capable of using our time fully and wisely to ensure the productivity we had before the pandemic. And I think sustainability is essential for research efficiency and productivity.”
- “There is an increase in use of electronic signatures, as a result less paper being used”

## **Have you seen a difference in efficiency/productivity since the pandemic, how do you think it has affected sustainability in your lab?**

- In some cases no changes were observed or instead a loss of productivity though home-working has resulted in some increases in productivity
- Sustainability only affected by decreased work / travelling
- More waste as a result additional cleaning and safety precautions
- Supply chain issues, surplus ordering, unknown analytical needs
- Many have found that the pandemic has disrupted previous habits, offering an opportunity to optimise procedures and consider alternative methods
- Additionally, some found increased planning has led to increased efficiency, time management and productivity

# Are your colleagues open to optimising methods/working process in the lab with consideration to sustainability? If so, what approaches do you take?

- “Unfortunately, not all.”
- “Older colleagues are not easily open to change. We, the younger generation, should try to have more discussions about sustainability issues.”
- “Yes, however it can take a while before new working processes become a habit. For new techniques training is very important.”

## Are your colleagues open to optimising methods/working process in the lab with consideration to sustainability? If so, what approaches do you take?

- “I’m not sure of others, but I write methods so as to use as few different pipettes as possible and maximize well usage on 96-well plates so as to minimise waste.”
- “More or less yes. Workflow with less solvent consumption and therefore less waste.”
- “I think people would be more open to do this if the conversation was opened and there was the time to do so.”



# Are your colleagues open to optimising methods/working process in the lab with consideration to sustainability? If so, what approaches do you take?

- “Mindful use of matrix”
- “Microsampling techniques”
- “Reducing the use of organic solvents and workflow times”
- “We have a LEAN club”

## **Are your colleagues open to optimising methods/working process in the lab with consideration to sustainability? If so, what approaches do you take?**

- Most find colleagues are open to the idea of optimisation with consideration to productivity, though not all, opening a dialogue is important
- Some noted an attitude of “it’s always been done this way”
- Approaches taken consist of:
  - Creating/optimising methods with minimised workflows to allow reduced sample, matrix and reagent volumes
  - Minimising waste production using efficient methods
- Proper training was also highlighted as important to help make sustainable methods and behaviours a habit

## How can we achieve improved waste management?

- “Correct experimental designs that leave no gap and lead to the acquisition of surplus and useless material.”
- “Only using/preparing/decanting the required volume or weight of a material without any excess.”
- “Improve communication between operators to encourage the sharing of common reagents and solvents.”
- Thorough training of operators to achieve in-depth understanding of instruments working cycles in order to optimize their use.”

## How can we achieve improved waste management?

- “Discriminate what can actually be cleaned and reused from what must necessarily be disposable.”
- “Relationships could be set up with suppliers to return particular packaging/ bottles that could be reused.”
- “Promote awareness of recycling processes, where is it going etc. Can help reduce unnecessary waste”
- “Companies that provide us with reagents, should have recyclable packaging. They should reduce the packaging material to the minimum to reduce the waste quantity.”

## How can we achieve improved waste management?

- Efficient and correct method design with proper training and optimised routines, maximising productivity and efficiency and minimising waste
- Consideration to resources – what must be disposed of vs what can be saved?
- Separation of waste to allow efficient recycling e.g. different bins in the lab for different waste
- Increased communication and demand:
  - With colleagues to share common reagents
  - With suppliers to find ways to recycle/re-use packaging, get the suppliers involved in increasing sustainability
  - Promote awareness of recycling processes

## **Which processes have you already implemented within your team to save resources?**

- “Avoid the use of paper, recycle paper and cardboard”
- “If possible, materials and reagents re-tested to extend expiry dates.”
- “Detailed and updated reagents database with useful information and residual quantities, to facilitate reagent sharing.”
- “Equipment / “old” systems are forwarded to universities instead of being disposed.”

## Which processes have you already implemented within your team to save resources?

- “Microsampling and miniaturisation of pre-treatment processes”
- “Columns put back into general use when a study has been completed. All new methods are developed and tested on regenerated columns which are still suitable for use.”
- “UPLC instead of HPLC; lower flow rates.”
- “SPE instead of LLE.”

## **Which processes have you already implemented within your team to save resources?**

- “More options for bulk ordering to reduce packaging”
- “Improved calculations for reagents to order very minimum required”
- “Implement a system to track equipment usage and to share, in order to save time, energy, money, and resources”



## Which processes have you already implemented within your team to save resources?

- Universal processes we can all try to do:
  - Cut down on using paper, recycle paper/cardboard when used
  - Passing on old equipment rather than disposing of it
  - Where possible re-test materials and reagents
  - Efficient method design
  - Sharing of common reagents
  - Bulk ordering system
  - Equipment usage tracking for sharing “sharing is caring”
- Processes more specific to types of bioanalysis:
  - Implementation of microsampling
  - Changing to newer technologies vs older ones, e.g. UPLC vs HPLC
  - Re-using columns where possible

## Do you think YOU should/could be doing more?

- “Being sustainable involves having to have a plan and thinking ahead which it is not always possible to do.”
- “There has to be a balance between waste management/sustainable lab and the amount of time/resources that is invested into this.”
- “I am capped at what I can personally do within regulated bioanalysis by my company and their finance budgets.”

## Do you think YOU should/could be doing more?

- “Yes, I should be enhancing discussion in order to culture sustainability mindset, so that we could implement small measures in the lab”
- “What we could probably all do more, without effort, is shut down our computers on a daily base, turn off the fume hoods when they're not in use, turn off the lights of all labs every day.”
- “Upon development of a new method, think about alternatives, instead of sticking to old habits.”

## Do you think YOU should/could be doing more?

- “It isn’t just an individual problem, it relies on the participation of suppliers, other companies, governments and society to create opportunities for contribution to a sustainable world”
- “Important for passionate people to come forward to be a champion for change and lead by example, and for those around them to inspire and support change”

## Do you think YOU should/could be doing more?

- Unanimous agreement more could/should be done with some caveats and suggestions
- Implementation of sustainability requires planning, time, resources, and money. Leads to restrictions as costs must be balanced with the gains.
- Sometimes restricted by position and ability to effect change
- Do more to promote discussion on the topic both individually and in society
- Challenge the “this is how we’ve always done it” mentality
- Small changes – turning off monitors, fume hoods, lights etc.
- Switch to greener solvents if possible

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