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TNO innovation for life

Finding evidence of chemical weapons use in plants

Mirjam de Bruin-Hoegée[a,b], Latifa Lamriti[a,b], Marcel van der Schans[b], Daan Noort[b], Arian van Asten[a,c]

[a] van 't Hoff Institute for Molecular Sciences, University of Amsterdam, [b] TNO Defence, Safety and Security, CBRN Protection, Rijswijk, The Netherlands, [c] CLHC, Amsterdam Center for Forensic Science and Medicine, *Corresponding e-mail address: *mirjam.debruin@tno.nl*

Objectives

- Detecting persistent biomarkers in plants after chemical warfare agent exposure
- Identifying modified plant proteins using LC-HRMS/MS

Background

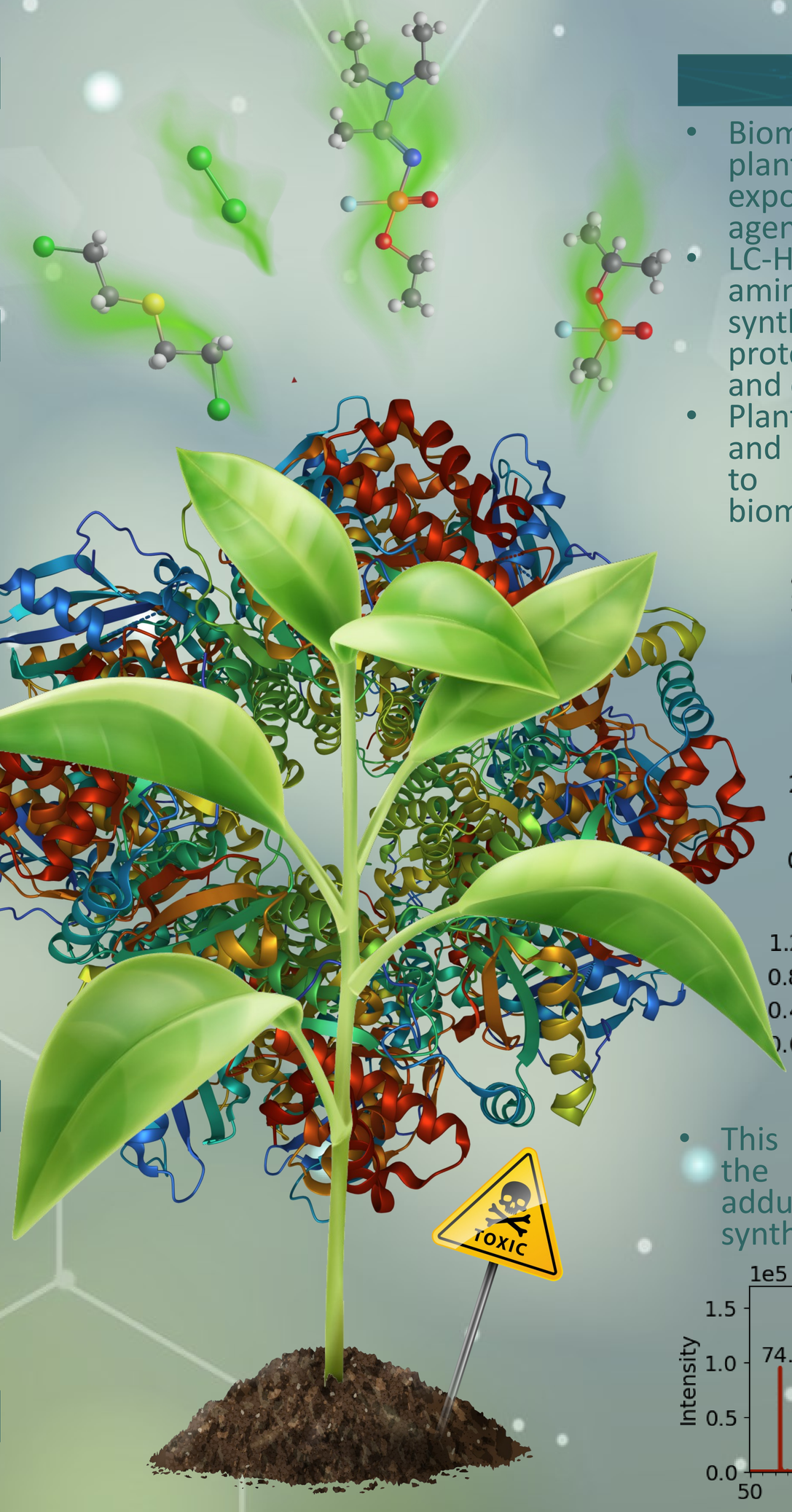
After the release of toxic chemicals, it is often difficult to detect the intact chemicals due the volatility and reactivity. As plants are all around us, they could potentially be used as sensors of chemical weapons.

Approach

Problem: Long-lasting protein adducts have only been detected in humans and not in biological samples.

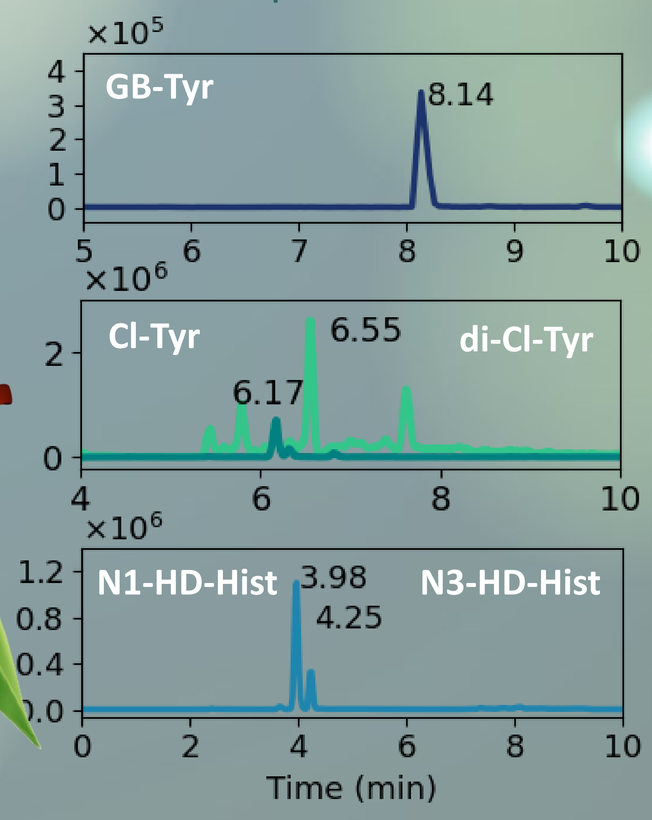
Question: Is it possible to detect persistent biomarkers in plants after exposure to chemical weapons?

Method

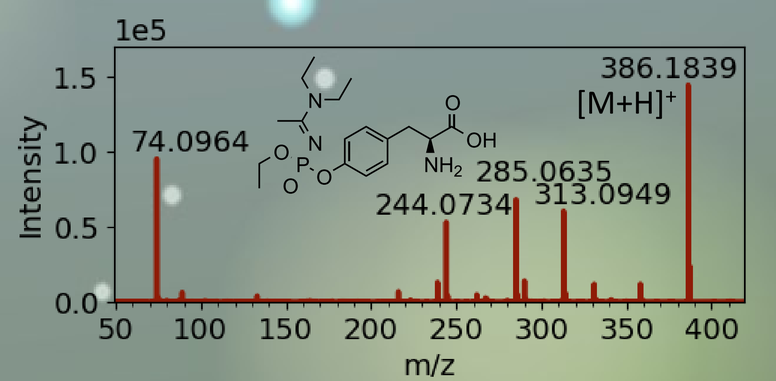


Main findings

- Biomarkers could be detected in plants up to three months after exposure to chemical threat agents.
- LC-HRMS/MS identified modified amino acids in Rubisco, ATP synthase, and chlorophyll binding protein for all types of vegetation and exposure conditions.
- Plant markers of chlorine, sarin and sulfur mustard were similar to established biomarkers in biomedical samples.



- This is the first study to identify the Novichok A-234 tyrosine adduct by comparing it to a synthetic reference standard.



Results

Top: untreated, bottom: chlorine exposed nettle over a period of 24h

Conclusion

A novel approach was developed for analyzing persistent biomarkers in vegetation for forensic investigations of chemical warfare agent exposure.

Future research

- Initial plant screening with fluorescence
- Improving detection limit by processing more plant material

[1] M. de Bruin-Hoegée, L. Lamriti, J.P. Langenberg, R.C.M. Olivier, L.F. Chau, M.J. van der Schans, D. Noort, A.C. van Asten, Verification of exposure to chemical warfare agents through analysis of persistent biomarkers in plants, *Analytical Methods. 15* (2023).

mirjam.debruin@tno.nl
forensicscientist.nl
@MBruinHoegee
mirjamdebruinhoegee

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