

Dioxin testing sets the standard for trade opportunities between the EU and China

Fera Science Limited embarked on an ambitious project to implement GC-MS/MS dioxin testing as part of the EU-China Safe Project for food safety standards and authenticity.

Through collaboration with Thermo Fisher Scientific, the Fera team achieved:

- Validated GC-MS/MS dioxin analysis with standardized e-workflows in a virtual laboratory setting.
- Successful twinning of laboratories for productive and flexible dioxin testing.
- Mutual recognition between the EU and China for best practice methodology.

In September 2017, a landmark project was initiated between the EU and China to combat food safety and fraud issues: the EU-China Safe Project would develop a shared vision for food safety standards and authenticity, while improving trade relationships.

Polychlorinated dibenzo-p-dioxins and polychlorinated dibenzofurans (dioxins) in food and feed was a key area of concern. China needed to increase its testing capacity for these highly toxic chemicals, and new techniques and technology were required for interlaboratory validation of dioxin analysis methods. This validation would also be used to demonstrate the concept of the virtual Reference Laboratory 2020 (RL2020), which would facilitate knowledge transfer, harmonize procedures and allow for mutual recognition of results.

Fera has a 100-year history of food testing and with more than 350 scientists and technical specialists working

across the agri-food supply chain, the company currently analyses approximately 100,000 samples a year. As the UK National Reference Laboratory for halogenated persistent organic pollutants – including dioxins – in food and feed, Fera was appointed to develop a dioxin analysis methodology for use in Chinese and European twinned laboratories and lead a work package to create the RL2020. Fera approached Thermo Fisher Scientific to help identify an easily replicable method for dioxin determination in multiple locations; the teams agreed on gas chromatography-triple quadrupole mass spectrometry (GC-MS/MS) as the technique. The latest GC-MS/MS technology provided simple implementation, straightforward use, robust workflows, time savings and accurate performance, helping to reach a key milestone in this important project.



Supply chain complexity fuels food safety issues

As global demand for food surges and supply chains become more complex, the risk of safety incidents and fraudulent activity increases. The 21st Century has seen huge improvements in global food safety standards, but when incidents do occur, they often have large impacts on health, and cause widespread economic and reputational damage. Dioxins are of particular concern in both food and feed; these fat-soluble, highly toxic compounds bioaccumulate, causing lasting and extensive damage throughout food chains. The Irish Pork Crisis in 2008 is perhaps one of the starkest examples of dioxin contamination, when pork products were found to contain up to 200 times the legal limit¹. The source was located to animal feed and the incident led to the destruction of €125 million (around \$147 million)² worth of pork products and long-lasting damage to the reputation of Irish meat producers. Incidents like this highlight the need for a system that identifies and addresses emerging issues before they affect global trade and consumer safety.

Taking the collaborative approach to address emerging issues

The EU-China Safe Project was created as a direct response to food safety issues. With 15 EU and 18 Chinese government and industry research organizations participating, the project is a truly collaborative initiative. Developing a standardized, reliable and straightforward method of dioxin analysis was critical to achieving mutual recognition of quality assurance, analytical methods, verification criteria and training. These were key components in creating a transparent and collaborative virtual laboratory. In this space, scientists can now establish methods, foster best practices and share results.

Using partnership to power choice

Until recently, magnetic sector high-resolution mass spectrometry (HRMS) has been the only EU validated

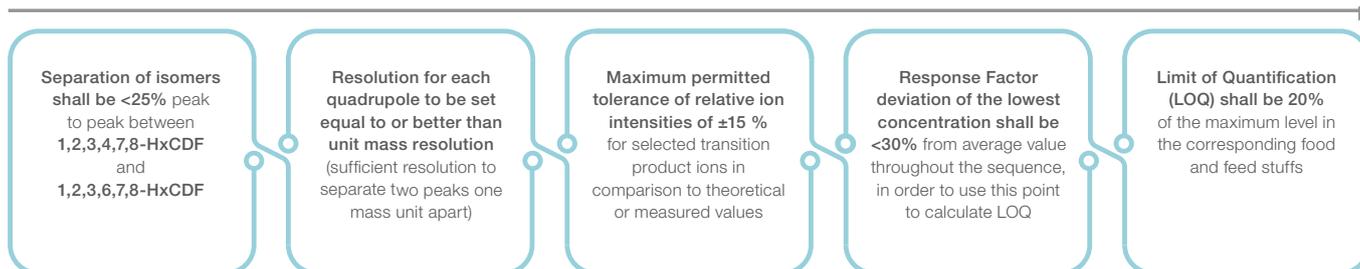
technique for measuring dioxins in food and feed for regulatory compliance testing. Although magnetic sector HRMS is a highly sensitive technology that produces high-quality results, the equipment is large, needs additional laboratory infrastructure and requires specialist operators. With diverse geographical locations and facilities, the EU-China Safe Project required alternative technology with shorter set-up times and fewer training requirements.

Recent advances in GC-MS/MS technology mean that this equipment can now detect very low dioxin levels, as low as sub-parts per trillion. In 2017, this breakthrough led to the realization that GC-MS/MS methodology may be able to meet the analytical criteria demanded by the European Commission for regulatory compliance testing. Fera required a collaborative partner to help select appropriate GC-MS/MS technology capable of delivering the high levels of validation required. This technology would have to be readily available and easily implemented in laboratories across the EU and China.

Thermo Fisher recommended and supplied identical GC-MS/MS instrumentation and technical support to colleagues in both the UK-based Fera and the China National Center for Food Safety Risk Assessment (CFSA), Beijing, laboratories. The package included the dioxin analyzer analytical e-workflow, providing standardized methodology from sample extract to result. The dioxin analyzer includes robust GC-MS instrumentation, a specialist dioxin column for excellent chromatographic resolution and Thermo Scientific™ Chromeleon™ chromatography data systems (CDS) software with pre-configured templates to simplify reporting.

These workflows were built for easy implementation and reproducibility in any laboratory setting³, supporting the knowledge transfer required for successful laboratory twinning.

EUROPEAN COMMISSION PERFORMANCE CRITERIA



EU quality performance criteria for routine use of GC-MS/MS for confirmational analysis

Creating the blueprint for the virtual laboratory concept

On behalf of the EU-China Safe Project, Fera selected the Thermo Scientific™ TSQ 9000 Triple Quadrupole GC-MS/MS system fitted with an Advanced Electron Ionization (AEI) source. Along with the ultra-sensitivity needed to detect trace dioxin levels, the technology was chosen for its simple implementation, automated set-up, robustness and comparatively small footprint.

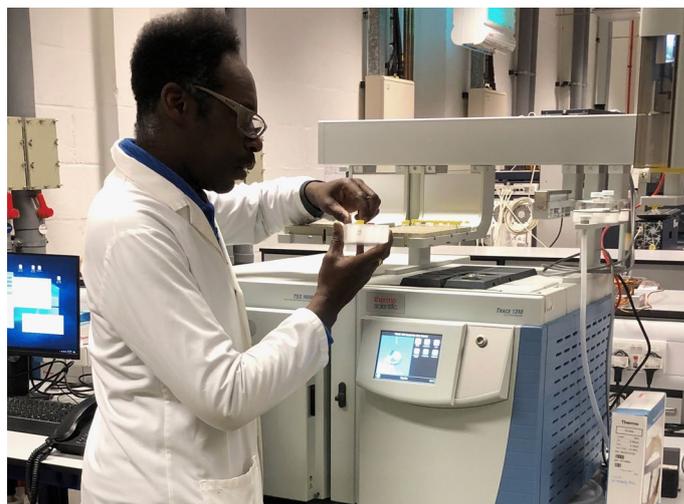
“Creating robust interlaboratory validation of dioxin determination was an important step in this project, particularly as the workstream would also validate the virtual laboratory concept,” explains Martin Rose, Fera. “We knew the Thermo Fisher GC-MS/MS technology was able to meet the analytical criteria demanded by the European Union regulatory requirements; it provides the depth and breadth of analysis without the technical expertise needed for magnetic sector HRMS. This means the laboratories could use multi-skilled scientists with minimal additional specialist training.”

Setting up a virtual dioxin-testing laboratory would have been difficult in the best of times, but this project had to be implemented during the COVID-19 lockdowns. A pandemic backdrop proved the ultimate test of virtual collaboration. Instruments were loaned to both locations, and remote set-up, validation and training were coordinated by the Thermo Fisher team during regional lockdowns.

“Communication was key,” explains Susan MacDonald, project manager for EU-China-Safe at Fera “We had regular meetings to establish a two-way communication channel between our scientists and technical experts at Thermo Fisher. The open dialogue meant that we could ask for advice and receive timely feedback on the work that was being carried out, both at Fera and in China.”

“Despite the conditions, the support we received from Thermo Fisher allowed for a straightforward set-up, and technicians were trained and ready to use the equipment within a few days,” continues Rose. “The dioxin testing capability is now online and colleagues in both locations are successfully working on real samples. The method has been independently validated at Fera and we obtained excellent results for proficiency test samples across a range of matrices. Above all, this project has created a blueprint for future technology selection and further development of RL2020.”

Chromeleon CDS software was used to create e-workflows, enhancing productivity and establishing



best-practice methodology. Automatic sample calculations provide the basis for fast, error-free analysis without the need for additional software. This includes calculation of metrics such as toxicity equivalence (TEQ), confirming that results and calculations meet quality and compliance requirements, as well as ¹³C-labelled standards recovery, ion ratio, sum parameters and LOQ flagging. Automated data calculations deliver higher throughput without compromising accuracy. Reports created through pre-defined templates deliver considerable time savings. Furthermore, the software is compliant with EU and Chinese regulations, giving assurance to procurement teams and making audits simpler.

“Dioxin analysis is notoriously challenging,” confirms Sean Panton, lead scientist on the RL2020 project. “We are analyzing sub-parts per trillion while developing best practice workflows for quality assurance purposes. The analysis needs to be robust and repeatable, and the e-workflows make this possible. Automated reporting simplifies complicated calculations and the system was ready to use out of the box.”

Data transparency, straightforward procedures and robust workflows were the drivers behind effective collaboration to reach mutual recognition of standards and methodology. “Using GC-MS/MS technology for dioxin analysis was a game-changer for this project,” confirms Rose. “The increased sensitivity of these new models means high-quality results are achievable, while the laboratories save time, money and space. Of course, magnetic sector HRMS still has a place in food and feed testing, particularly when analyzing very low levels of dioxins and other contaminants, but for the majority of the analysis needed to make the EU-China Safe Project a success, the TSQ 9000 GC-MS/MS system with AEI, delivers above and beyond our requirements.”

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With the successes seen in dioxin analysis, Fera is now exploring other GC-MS/MS applications that require high sensitivity analysis, including polycyclic aromatic hydrocarbons, polychlorinated biphenyls and glycidyl esters.

Setting the benchmark for dioxin analysis

The successful installation and validation of Thermo Fisher GC-MS/MS technology have set the standard for dioxin analysis as a part of the EU-China Safe Project. Furthermore, together with CFSA, Fera has used dioxin analysis to validate the concept of RL2020, providing the benchmark for further food and feed testing capability within the EU-China Safe Project.

Through a consultative partnership with Thermo Fisher, the EU-China Safe Project gained access to technology that provided the optimal levels of dioxin analysis in a way that best fit the needs of laboratory teams in all locations.

Scientists can now run standardized workflows and reprocessing methods, and access automated data reports through the Chromeleon CDS software, saving time while increasing accuracy. This platform provides the space for collaboration to solve complex problems

relating to dioxin analysis and validation of data. In this period of increased demand and global trade, the dioxin analysis methodology demonstrated in the virtual laboratory will help set the standards for safe food trade between the EU and China.

The EU-China Safe Project continues towards completion in 2021, building on the successes of the dioxin analysis workstream and RL2020 proof of concept.

“Implementing GC-MS/MS technology for use in standardized dioxin analysis is a huge success within the EU-China Safe Project and its impact will ripple from here,” concludes Rose. “From being involved in the original ring trials that resulted in the EU regulation changes, to seeing RL2020 successfully implement this technology, it is clear that we have come a long way in a short amount of time. The huge advances in GC-MS/MS technology and the support of the expert team at Thermo Fisher Scientific has enabled this vision to become a reality. This is just the start of the wider adoption of GC-MS/MS technology in high-sensitivity analysis.”

¹ <http://news.bbc.co.uk/1/hi/uk/7770476.stm>

² <https://www.theguardian.com/uk/2008/dec/09/irish-pork-dioxins-food-scare>

³ Thermo Fisher Scientific Application Note 10703: Routine, regulatory analysis of dioxins and dioxin-like compounds in food and feed samples.

Find out more at www.thermofisher.com/dioxin-analyzer

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