

Government Chemist

Review 2023

CP 1325



Department for
Science, Innovation
& Technology



Government Chemist Review 2023

Presented to Parliament by the Parliamentary Under-Secretary of
State for AI and Digital Government by Command of His Majesty

June 2025



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Foreword from the Government Chemist



I always feel fortunate to be able to bring the activities of the Government Chemist to wider attention on an annual basis through this Review. This year especially, I can truly hold my hand to my heart and feel pride at the strides we make as a team. Why is this?

Well, monitoring and evaluation of national infrastructure by government is a crucial part of ensuring the systems it funds continue to provide work of high quality and value for money to the UK and are prepared for future challenges. The International Science Review, commissioned by the Department for Science, Innovation and Technology (DSIT), independently evaluated the quality of science and the impact of the Government Chemist role over the period 2016 to 2023. The Review Board concluded that the work of the Government Chemist was “internationally competitive (comparable with other world-class laboratories internationally)”. There was “significant and appropriate engagement with end-users and stakeholders

to meet the needs of the UK government, industry and wider society.” The Government Chemist is a “strategic national asset, uniquely placed to fulfil critical national roles serving the public interest” and an “integral and indispensable component of the UK’s National Measurement System (NMS), addressing the UK’s measurement needs in chemical and biological metrology in an impactful and cost-effective way.”

I am, of course, very proud of the conclusions that the Board have drawn; they mark significant external recognition of the experience and efforts of the team across many years. They are, of course, but a line in the sand; and we are not for standing still! Like ourselves, the Review Board recognise the challenges we face to support capability building across the UK food and feed system in growing areas of significant national progress, whilst also leveraging them internationally to enhance the UK’s scientific reputation.



The national role of the Government Chemist is internationally competitive with other world-class laboratories

At a more operational level, the flurry of referee cases seen immediately post-pandemic has declined over the year. Such fluctuation in case number is not new but, rightly, focuses attention by all interested stakeholders on understanding the reasons and, where possible, identifying solutions within the remit of the Government Chemist role. We continue to monitor the situation carefully.

Beyond the Government Chemist statutory referee function, I have welcomed the recognition of the benefit and value of the team's wider advisory contributions to a number of departmental and strategic cross-departmental issues, Devolved Administrations, as well as NGOs and industry. Those more significant contributions are laid out in this Review.

Finally, as indicated in last year's Review, the current Government Chemist Strategy and Programme was developed to start addressing activities that support strategic government and sector drivers towards a more sustainable circular food economy. It was a great pleasure therefore for me, as Government Chemist, to

be invited by the Royal Society of Chemistry (RSC) with support from UKRI-EPSC to lead the UK delegation to the 9th Chemical Sciences and Society Summit (CS3) in Tokyo on 'Chemistry for Sustainable Food: Challenges and Perspectives' and lead the workshop session on Circular and Sustainable Chemistry for Food Sustainability, exploring the role of, and priorities for, chemistry. The resulting White Paper from the summit will be available in 2024.

Our current ambition clearly remains. I am confident that the path to future success is clear, even if challenging. I look forward in my second term as Government Chemist to steer our activities to ever more clear and tangible outcomes.



Professor Julian Braybrook
BSc, PhD, Hon DSc, CChem FRSC

Note from the Chair of the Government Chemist Programme Expert Group



The Government Chemist function, present for well over 175 years in one form or another, is a government asset and as such comes under scrutiny to ensure it delivers high quality work and value for money for the taxpayer. This function falls on a national basis, year-to-year, to the Programme Expert Group that I chair. International scrutiny is sought, as Julian explains in his Foreword, on a usual 5-year cycle. The latest such International Science Review of the programme found the Government Chemist function to be meeting or exceeding expectations, both technically and through its impact on society. As Chair of the Programme Expert Group I am pleased to extend my congratulations to the whole team on achieving the recognition that it deserves.

Another particular highlight of 2023 was the Government Chemist Conference, held in-person for the first time since 2018 (there was an online conference in 2021). Held at the Royal Society of Chemistry in London, stakeholders from the food and feed sector representing

industry, academia, regulators and government came together to provide perspectives on how the current geopolitical, environmental and economic conditions are creating challenges for global food security. Presentations and discussions focused on possible innovative solutions and mitigation tools to help ensure safe food for the future. The conference was a clear success, providing a very welcome opportunity to network with colleagues and engendering conversation and collaboration opportunities that continued after the event.

Engagement with its stakeholders has always been a priority for the Government Chemist team. It not only provides a means to communicate the progress and findings of the referee function, but it also informs the team of current and future needs. This Annual Review offers just a few highlights of where the team has contributed to meetings, committees and other events. As the Programme Expert Group, we receive quarterly updates on all forms of engagement being undertaken and we are



always impressed with the frequent degree to which the expertise of the Government Chemist and team is called upon, be it through leadership or invitation to working and expert groups or committee attendance, or through material available from the [gov.uk/government/chemists](https://www.gov.uk/government/chemists) webpages.

It is also worth noting how the work programme has responded to key drivers identified by stakeholders in previous years. It now includes projects focused on sustainability of the food economy, such as novel food production methods, use of alternative proteins and measurement methods for microplastics in food, to mention but a few examples. My colleagues on the Programme Expert Group and myself are looking forward to learning about the outcomes of these and other projects in the programme during the next three years.

I hope you find the content described in this review not just interesting, but also informative about the world-class science being performed in the UK by one of our oldest scientific institutions and the impact it has on our everyday lives.



Professor Paul Berryman

BSc, MSc, MChemA, MBA, PhD, CBiol FRSB, CSci FIFST, CChem FRSC

“

The work programme has responded to key drivers identified by stakeholders in previous years, and it now includes projects focused on sustainability of the food economy, such as novel food production methods, use of alternative proteins and measurement methods for microplastics in food



What we do

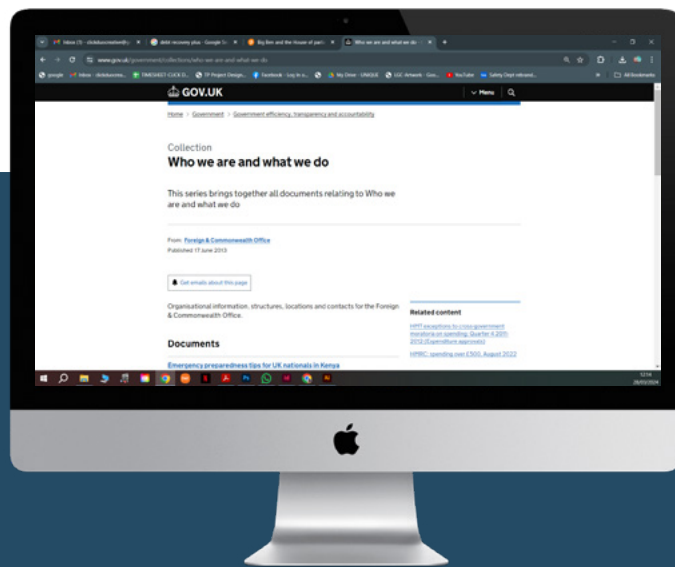


The Government Chemist role was created originally to help in the protection of the public from fraud, malpractice and harm. In 1875, the laboratory was appointed as “referee analyst”, a role linked to the Sale of Food and Drugs Act of that year.

The role continues to this day, fulfilling statutory and advisory functions, funded by the Department for Science, Innovation and Technology (DSIT).

The Government Chemist uses authoritative measurement procedures coupled with experienced interpretative skills to act as a fair and independent arbiter to resolve disputes. In doing so we protect consumers, provide a route of technical appeal for businesses and contribute to regulatory enforcement in sectors where chemical and bio-measurements are important.

The Acts and Regulations under which the duties of the Government Chemist as referee analyst are listed in the **“What we do”** section of the Government Chemist website (www.gov.uk/governmentchemist).



The Government Chemist’s statutory function comprises science-based duties prescribed in several acts of Parliament. These duties cover public protection, safety and health, value for money and consumer choice

Our statutory function

The Government Chemist’s statutory function comprises science-based duties prescribed in several acts of Parliament. These duties cover public protection, safety and health, value for money and consumer choice. Our most important responsibility is to act as a “referee analyst” resolving disputes between regulators and businesses, supported by our own independent measurements, interpretations and expert opinions. Thus, we reduce the burden on

public finances as successful resolution often avoids recourse to legal processes and derives secondary spill-over effects by helping maintain a core national analytical testing infrastructure. Our credibility as the referee, and our ability to develop new capability for future challenges, rest on first-class science which is underpinned by the designation of our home laboratory, the UK National Measurement Laboratory for chemical and biological measurement at LGC.

Our advisory function

The long history of the Government Chemist function and its involvement in regular and wide-ranging dispute cases means that the team is well placed to provide advice on analytical science implications for policy, standards and regulations. We mainly deliver this function by responding to government calls for advice or published consultations, where there is a significant or important analytical science content. Consultation responses are published on the Government Chemist website; consultation responses for 2023 have been listed on page 23 of this Review.

Our capability building

Referee analysis is often most challenging in areas where measurements are difficult, where novel products are being introduced into the market or where there is high public and media interest, for example allergen detection.

Our strategy for the next three years

The Government Chemist programme for the period of 2023 to 2026 focuses on four strategic aims:

- Protecting consumers in increasingly challenging times;
- Supporting business and government across the four nations of the UK;
- Collaboratively building a resilient national skills base;
- Maximising UK measurement expertise to address global challenges.

The work programme under each of the aims places great emphasis on plans to enhance cross-government working across the UK infrastructure and internationally, to demonstrate leadership in matters relating to measurement science in line with stakeholder technological and regulatory needs, and helping to address global challenges.

Our governance

Responsibility for the Government Chemist programme lies with the Department for Science, Innovation and Technology (DSIT).

DSIT has put into place arrangements to ensure that the Government Chemist programme delivers value for money, and that scientific standards, impartiality, transparency and integrity are maintained.

The Government Chemist Programme Expert Group (GCPEG) provides independent scrutiny, overseeing the planning, delivery and impact of the programme, and offering advice to DSIT regarding future priorities and strategic direction of the programme.

The GCPEG comprises representatives of regulatory and enforcement bodies, industry, trade and consumer associations, and academia, each with a broad range of backgrounds, skills and interests.

Government Chemist Programme Expert Group membership during 2023



Paul Berryman, Chair

Paul is the Director of Berryman Food Science Ltd, which works closely with government and businesses, including the Health Food Manufacturers' Association (HFMA), UKRI-Innovate UK, Department for Business and Trade (DBT), Food Standards Agency (FSA), EY, PwC, Aldi, Fera and SGS Ltd. He is a visiting Professor at the University of Reading.

Simon Branch

Simon is Senior Director of Research, Development and Scientific Affairs at Herbalife. He has sat on a number of Boards and committees including the Royal Society of Chemistry Science (RSC) and Technology Board. He is the current Chair of Campden BRI's Advisory Council.

John L Collins

John has a multi-disciplinary background with experience in R&D, materials and product development, manufacturing and manufacturing technologies, international trade and technical sales.

David Franklin

David leads the Scientific Sampling and Laboratory Policy Team in the FSA which is responsible for policy and scientific advice for Official Control Laboratories, National Reference Laboratories and Sampling.

Jonathan Griffin

Jonathan is a Public Analyst and Technical Manager for Kent Scientific Services and former President of the Association of Public Analysts.

Kasia Kazimierczak

Kasia leads a multidisciplinary team covering marine science and shellfish hygiene, authenticity, and surveillance at Food Standards Scotland (FSS).

Chelvi Leonard

Chelvi is Policy Lead for Accreditation at the Office for Product Safety and Standards (OPSS), Department for Business and Trade. Chelvi was the UK representative at CEN and Codex meetings in the standardisation of analytical methods for food.

Brenda McRory

Brenda is a Technical Lead Officer at Suffolk Coastal Port Health Authority. Brenda currently leads on imports of food and feed of non-animal origin, plastic kitchenware, organic food and feed, catch certification for wild caught fishery products and public health controls on vessels arriving at the port of Felixstowe.

Declan Naughton

Declan is currently Professor Emeritus of Biomolecular Sciences at Kingston University London with wide ranging research interests from food safety and nutrition to drug discovery and endocrinology. He was also Interim Dean for Research and Enterprise for the Faculty of Health, Science, Social Care and Education until 2024.

Government Chemist Programme Expert Group membership during 2023 continued...

David Pickering

David is a Trading Standards Manager for the Buckinghamshire and Surrey Trading Standards Service. He has been the Chartered Trading Standards Institute Lead Officer for food for many years and represents the profession on numerous groups including the national Food Standards and Information Focus group.

Sophie Rollinson

Sophie is a scientist in Defra's Agri-Food Chain Directorate and manages the Government's Food Authenticity Research Programme, which develops methods to detect food fraud and support enforcement of food labelling and standards rules. Sophie has over 20 year experience in various government roles at Defra and FSA covering food standards and labelling, microbiological food safety and food authenticity.

Diane Turner

Diane is the Founder, Director and Senior Consultant of Anthias Consulting Ltd, an independent provider of analytical training and consultancy. Diane is a visiting fellow and consultant at The Open University, immediate Past-President of the RSC Analytical Sciences Community, and immediate Past-Chair of the Analytical Chemistry Trust Fund.

Our people

LGC staff who directly support the Government Chemist function have clear and independently defined roles (Figure 1). Within this framework, there are particular requirements for the management of statutory casework:

- Nominated officers, one of whom holds the requisite statutory qualification for Public Analysts, have overall responsibility for case supervision. They prepare and sign Government Chemist certificates of analysis;
- Only the Government Chemist or Deputy, once satisfied that the case has been properly completed, countersigns the certificates of analysis.



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Figure 1 Government Chemist contact points



In focus:
**High value-added
chemicals from
unavoidable food
supply chain wastes**



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Deputy Director, Green
Chemistry Centre of Excellence,
Department of Chemistry,
University of York

Background

Approximately 33% of food produced globally is lost between harvest (farm) and retail (fork) comprising both avoidable and unavoidable food supply chain wastes (UFSCW). Many practices, procedures and policies are in place to reduce avoidable losses, and where possible, maintaining nutritional value for human health. UFSCW arise due to primary and secondary processing of food and generates approximately 30-35% losses that may be utilised as animal feed, as compostable matter or for energy production (waste to energy). However, UFSCW are a rich source of exploitable biomolecules and biopolymers that present an alternative value proposition beyond just waste to energy. UFSCW may be considered as Nature's Periodic Table of biobased feedstocks, delivering a range of diverse applications based on their inherent structure and functionality.

Valorisation of UFSCW will require thorough monitoring, analysis, quality assurance and validation of the emanating products to ensure that they are safe and free from any unsafe chemical compounds that may arise during processing. In this article, the global drivers and the case for valorisation of UFSCW within the context of global sustainability, sustainable development goals and the bioeconomy are discussed. An orange peel waste biorefinery is exemplified as a case study to show the chemical value potential and opportunity from UFSCW.



Unavoidable food supply chain wastes may be considered as Nature's Periodic Table of biobased feedstocks, delivering a range of diverse applications based on their inherent structure and functionality

Introduction

Planet Earth is under severe stress due to unsustainable practices and processes in production (manufacturing), resource acquisition and consumption needed to meet the demands of an increasing global population; 8 billion today and expected to increase to over 9 billion by 2050.¹ In order to feed our future population, global food production will have to increase by at least 70% by 2050,² placing a huge strain on virgin resources. Industrialised nations are resource intensive societies, heavily reliant on crude oil (petroleum) and gas for their energy, chemical and material needs. However, crude oil is a non-renewable, finite resource and its continued use represents a major environmental burden. Thus, sourcing of carbon neutral, renewable, biobased feedstocks is of paramount importance as they also have added benefit inherent structure, functionality and chemical heterogeneity beyond just carbon and hydrogen atoms. The global drivers for development of biorefineries, enhanced bioresource utilisation and, transitioning from linear- to circular-economies are very compelling for a sustainable 21st century. Approximately 1 billion tonnes or one third of global food production for human consumption is lost or wasted per annum. The UK wastes around 9.5 million tonnes of food, of which approximately 30% is inedible or unavoidable.³

Valorisation approaches for food waste and byproducts streams can be regarded as reasonable solutions to reduce food supply chain wastes at meso- and macro-levels on the global food system.⁴ UFSCW represent an interesting high-volume, renewable, chemical and functional-rich, biobased feedstock for exploitation (valorisation) into value-added chemicals and materials.

¹ United Nations Data Portal Population Division <https://population.un.org/dataportal/home>.

² How to Feed the World in 2050. https://www.fao.org/fileadmin/templates/wsfs/docs/expert_paper/How_to_Feed_the_World_in_2050.pdf.

³ UK Food Waste & Food Surplus – Key Facts. <https://wrap.org.uk/sites/default/files/2024-01/WRAP-Food-Surplus-and-Waste-in-the-UK-Key-Facts%20November-2023.pdf>.

⁴ HLPE, 2014. Food losses and waste in the context of sustainable food systems. A report by the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security, Rome 2014.



Case study

Orange Peel Waste (OPW) Biorefinery⁵

Brazil, China, USA, Mexico and Spain account for approximately 60% of global citrus production, of which around 40% is sent to juice industry. Roughly 50% of an orange (by weight) is wasted during the juicing process. Several byproducts of economic interest can be manufactured from orange or citrus peel, namely: D-limonene (essential oil), pectin, dietary fibres, soluble solids, proteins, enzymes, citric acid, flavonoids and sugars.

D-limonene essential oil

The mixture of volatile compounds comprising orange essential oil (commercially named D-limonene since it accounts for ca. 90% of the oil) is certainly one of the main high-value products extracted from OPW due to its economic feasibility. D-limonene is present at 2-3% (dry basis) in OPW and is well-known for its bioactive properties (antimicrobial) having many applications in food, biomedical, home and personal care industry. Traditionally, citrus essential oil (including orange peel oil) is extracted by conventional methods such as cold pressing and steam- and hydro-distillation. However, these methodologies have some economic and environment drawbacks such as high energy input, high solvent usage, degradation of thermolabile molecules in the oil, loss of volatile compounds, oxidation and other chemical transformation of the oil components. To solve the aforementioned problems, essential oil from citrus fruits has been extracted using cleaner technologies, e.g. supercritical fluid extraction, ultrasound, subcritical water and microwave-assisted extraction. Microwave-assisted extraction on OPW successfully yields not only D-limonene essential oil, but also pectin, flavonoids and cellulosic matter without the burden of biomass pre-treatment.

Pectin

Pectins are complex polysaccharides present in non-woody biomass mainly in the primary cell wall and intercellular regions. Heat-assisted, acid hydrolysis of citrus peel followed by ethanol precipitation is a commonly used method for pectin extraction. Acid-free hydrothermal microwave assisted extraction of pectin has been explored as a 'greener' alternative in which the natural acidity of the juice is used to unlock pectin from cell walls.

Flavonoids and phenolics

The flavonoid and phenolic content of oranges has been well documented with potential health benefits including anti-inflammatory properties and antioxidant activity, which can also be used to prevent food rancidity and oxidation of lipids if used as a food additive. The main phenolic compounds reportedly present in orange peel are naringin and (neo)hesperidin which are commercially valuable components.

Dietary fibres

In the concept of a zero waste biorefinery, there is still scope for further valorisation of citrus waste in the form of dietary fibre utilisation. The uses for dietary fibre include clouding agents in beverages, thickeners and gelling agents along with binders, texturizers, and as a low calorie bulking ingredient.

⁵ Matharu, A.S., de Melo, E.M., and Houghton, J.A., 2016. Opportunity for high value-added chemical from food supply chain wastes. *Bioresource technology*, 215, 123-130.

Future feedstocks

Potato wastes: Potatoes are a large crop with an approximate global production of 370 million tonnes; the UK alone produces around 5 million tonnes.⁶ Between 3 to 13% of harvested potatoes never reach consumers because of 'grading losses', i.e. loss of potatoes that are not visually aesthetic enough to be sold for human consumption. Sub-standard potatoes are sent to be processed into lower value potato products or animal feed, sold at a far lower price. A common valorisation route for these potatoes is drying and grinding into 'potato flakes,' for use in applications such as instant mashed potato.

Potatoes are a rich source of starch and protein (patatin). Potato protein is considered higher quality than most other plant proteins due to the relatively high concentration of lysine, an essential amino acid. Protein extraction is an attractive addition to starch process lines because it would not change the base

processes. The protein is present in the aqueous waste stream created in starch production, so it would be possible to add a protein extraction plant to an existing starch production plant, creating a low-grade potato biorefinery system.

Tropical fruit waste: With increased availability of tropical foods in the market, tropical fruit wastes are an interesting source of food additives, preservatives, antioxidants, flavourings, anti-browning, colourants, texturisers and dietary fibres, with demonstrable economic and environmental benefits within the context of a 'zero-waste' approach. For example, global production of mangoes, mangosteens and guavas is estimated at 59 million tonnes⁷ with waste levels exceeding 14 million tonnes annually. Mango waste (peel, kernel and seed) contains antioxidants such as flavanols and xanthenes, polyphenols including mangiferin and quercetin 3-O-galactoside, food grade pectins as well as lipids with scope to be used as cocoa butter substitutes.

Between 3 to 13%
of harvested potatoes
never reach consumers



⁶ Food and Agriculture Organization of the United Nations. FAOSTAT Statistics Division. <https://www.fao.org/faostat/en/#home>.

⁷ Shahbandeh, M. 2024. Global mango production 2000-2022. <https://www.statista.com/statistics/577951/world-mango-production>.

Global production of mangoes, mangosteens, and guavas is estimated at **59 million tonnes**. Over **14 million tonnes** are wasted annually



Conclusions and challenges

A new paradigm in green and sustainable industrial processing technologies will be needed in the future to ensure efficient, benign and optimal resource recovery. The overarching ‘win-win’ situation will depend on the development of fully integrated biorefineries that will deliver biobased chemicals, materials and bioenergy. Based on the nature of the UFSCW, and in particular its longevity, some biorefineries will be located at source feedstock, whilst others may be centrally situated receiving UFSCW from many producers. The ultimate biorefinery should be UFSCW independent and amenable to convert a variety of feedstocks into chemicals, materials and energy.

Future processing of UFSCW into functional chemicals and materials, especially for those that re-enter the food chain, will need to ensure use of safe solvents, benign extraction

methodologies and where appropriate, processing speeds commensurate with nature and volume of feedstock. The use of emergent, enabling green and sustainable technologies (benign solid-liquid solvent extraction, pressurized fluid extraction, supercritical fluid extraction, ultrasound-assisted extraction, microwave-assisted extraction, pulsed electric field extraction, and enzyme-assisted extraction) allow for valuable chemical compounds to be extracted efficiently from unavoidable food waste biomass. Better knowledge and characterisation of incoming waste feedstocks is the key to applying the correct technology for product manufacture.

Analytical chemistry has an important role to play in the development of biobased circular economies to ensure that rogue, toxic chemicals and metabolites along the entire supply chain are effectively detected, monitored and removed, where appropriate.



**Protecting consumers
in increasingly
challenging times**



Consumer demand, high energy costs, the cost-of-living crisis and other geopolitical factors are driving changes to the way food is produced, sold and consumed. In addition, climate change will undoubtedly impact negatively on food systems and supply chains if left unchecked, making it increasingly challenging to fulfil the mission of providing food we can trust.



Embedding environmental sustainability considerations into practice will help influence the wider food ecosystem. Additionally, following EU Exit, the operating environment for many UK regulators has already changed significantly and they have taken on new responsibilities, which has resulted in delays in establishing new regulatory requirements or extending deadlines. Divergence from EU regulation also has the potential to cause confusion, increase barriers to sharing intelligence and potentially give rise to disputes in international trade.

The Government Chemist supports the UK Government in its aim to protect consumers and food businesses against these risks by providing definitive resolution of complex referee cases in a timely manner, providing measurement science advice on matters of national and international importance, monitoring regulatory developments through horizon scanning activities and continuing to work collaboratively with stakeholders to help prevent future disputes.

Dispute resolution

The Government Chemist underpins industry and public confidence in the food and feed official control system by guaranteeing independent impartial technical appeal to the highest standards. We maintain the credibility of this referee role by stringent governance, painstaking analytical rigour and well-informed interpretation of the resulting data.

Analytical results must be interpreted in an increasingly global supply chain and often in increasingly complex scientific, legal and policy contexts. Our default analytical strategy practically amounts to a stand-alone method validation and provides the necessary high level of analytical confidence. Significant analytical steps are witnessed by a second scientist and data transcriptions verified. The entire dataset is evaluated independently by statisticians for bias and outlying results and to yield a case-specific measurement uncertainty if required. A certificate is drafted and reviewed by a qualified person, before finally the case file is brought to the Government Chemist for peer review. If all steps are satisfactory the Government Chemist will allow the findings to be released.

The analysis of retained portions of samples referred to the Government Chemist (referee analysis) is more complex and resource intensive than the work of an official control or trade laboratory. This is necessary because:

- our results and opinion must be definitive and bear detailed scrutiny, sometimes at national and international level;
- referrals may be on matters close to a legislative limit, hence analytical confidence in our data must be of the highest standard; and
- the problems we seek to resolve may occur where the science, the law or both are uncertain or controversial.

Overview of referee cases in 2023

Referee cases – resolving disputes in the UK official control system for food and feed – is a demand led service, which has been at the core of the Government Chemist's function since 1875. Publishing the outcomes in our annual reviews and in more detail in peer reviewed scientific papers contributes to avoiding similar disputes in the future.

The number of referee cases received in 2023 has been significantly lower than previous years. Investigations into the reasons for this identified no single cause, however contributory factors may include the lower number of samples taken at local authority level, port health authority focusing on implementing the new Border Target Operating Model (BTOM) and industry becoming less aware of the referee role and function.

Mycotoxins are the chemicals formed by certain moulds when exposed to particular growing conditions. The maximum levels permitted in food are controlled by the Contaminants in Food (England) Regulations 2013 which invoke in England retained EU Regulation 1881/2006. The single referee case received in 2023 related to the presence of aflatoxin in dried figs.

The sample consisted of three laboratory samples which had been slurried at a ratio of one part sample to 1.5 parts water. The sample was extracted using standard conditions and analysed by HPLC with post column derivatization and fluorescence detection. The presence of any aflatoxin was confirmed using LCMS.

The mean results of analysis are given in the table below, expressed as micrograms of aflatoxin per kilogramme of dried fig, corrected for recovery and taking into account the added water.

Retained Commission Regulation 1881/2006 prescribes a maximum permitted level for aflatoxin B1 of 6 micrograms per kilogram and a maximum permitted level of 10 micrograms per kilogram for total aflatoxin in dried figs. Allowing for measurement uncertainty, the amount of aflatoxin B1 and the amount of total aflatoxin for sample A are in excess of the respective maximum permitted amounts. The sample was therefore deemed unsatisfactory in accordance with retained EU Regulations, and not permitted entry into the UK.

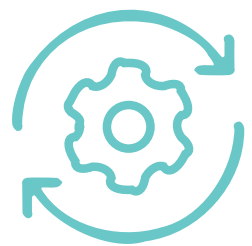
LGC Sample Reference	Mean Concentration Aflatoxin B1 ($\mu\text{g kg}^{-1}$)	U* ($\mu\text{g kg}^{-1}$)	Mean Concentration Total Aflatoxins ($\mu\text{g kg}^{-1}$)	U* ($\mu\text{g kg}^{-1}$)
Sample A	8.3	1.0	13.8	1.5
Sample B	0.2	0.08	0.6	0.2
Sample C	<0.1	-	0.4	0.2

*U is the expanded uncertainty, calculated as a 95% confidence interval, with appropriate degrees of freedom. The above uncertainties take due account of the uncertainty associated with variation in the analytical recovery.





**Supporting business
and government
across the four
nations of the UK**



The Government Chemist team provides world-class measurement science to support an innovative and growing UK agrifood sector to trade sustainably on a global basis. This is achieved through the provision of impartial technical advice as a valued expert resource, as well as application of excellent measurement science, forging meaningful dialogue with all stakeholders and participating and/or leading relevant committees and networks.

Advisory function

The Government Chemist provides specific advice related to measurement topics on a broad range of policy and regulatory developments to local, central and devolved administration governments, the European Union and the wider community of stakeholders. Scientific and measurement-based support is also provided to those industries where chemical and biological measurements are an important aspect of their activities. The publication of our outputs through the Government Chemist website is an important means of disseminating such advice, as well as receiving feedback.

Enquiries from stakeholders

Many stakeholders regularly turn to the Government Chemist for advice on a wide range of topics. Often the enquiries are related to measurement techniques and result interpretation. Sometimes expert opinion is sought on topical issues such as cannabidiol, allergens or food authenticity claims. We answered 54 requests for advice during 2023.

Figure 2 shows the source of the enquiries. Figure 3 shows the breadth of enquiries – measurement issues (food analysis), cannabidiol and authenticity being amongst the most common. The 'other' category included enquiries on allergens and veterinary medicines.

In each case we gave carefully considered advice, supplying a copy of peer reviewed research findings on the question where applicable, or referring the enquirer to another source of information.

The enquirers are invariably grateful for our time and advice.

Figure 2 Enquiries by source



Figure 3 Enquiries by topic





Expert opinion to stakeholders

The Government Chemist team is regularly called upon to provide expert opinion on matters of food analysis, regulation, authenticity and other similar topics by stakeholder organisations at meetings and events. Below are some examples of where the team has been able to contribute.

- Selvarani Elahi was interviewed by a team working on an FSA project at the University of Lincoln on the topic of 'Understanding Prevention Strategies to Reduce Food Fraud'. Selvarani outlined the role of the Government Chemist and the work done via the Food Authenticity Network to prevent food fraud.
- Selvarani contributed to a panel discussion on 'Ensuring Supply Chain Resilience when Facing Multiple Global Challenges' at the BRCGS Food Safety Europe 2023 event.
- The National Product Safety Group (NSPG) is the forum for UK practitioner experts for product safety and compliance consisting of trading standards officers and safety support by Office for Product Safety and Standards (OPSS). The group discusses national intelligence on product safety issues. Ian Axford attended the group meeting alongside government officials from OPSS and Health and Safety Executive (HSE), and Lead Regional Trading Standards Officers. Discussions focussed on chemical components in products including vapes and cosmetics.
- Malcolm Burns attended (as an invited expert) the European Commission (EC) Expert meeting on the future of Genetically Modified Organism (GMO) Certified Reference Material (CRM) production at the Joint Research Centre (JRC) (Geel, Belgium). Malcolm provided advice on what options the EC should consider to maintain CRM production at the current level of quality.
- Selvarani was invited to give a Keynote speech on 'Preventing miscarriages of justice in the UK Official Food Control System', which included an overview of the food system, evolution of food law and the role of the Government Chemist.
- Selvarani chaired a focus group meeting for the FSA Point of Contact (POC) technologies for food testing project, which is being led by Gavin Nixon and Malcolm Burns from LGC. The meeting posed various questions to stakeholders in relation to POC technologies and gathered their views.

Response to consultations

Consultations are carried out by the government (including the devolved administrations and agencies) or standards bodies to obtain the input of both interested and expert stakeholders on proposed new policy, guidance or legislation, prior to enactment. They are considered by legislators to be an important part of the development process for new legislation.

The Government Chemist has continued to provide input to these official consultations, being well-placed through the additional expertise within the National Measurement Laboratory and wider LGC organisation across a range of areas of analytical science, to respond authoritatively and independently where the consultations have chemical or biological measurement implications.

We responded to two consultations during 2023.

- 'Nutrition and health claims on food: proposed legislative reforms' published by the Office for Health Improvements and Disparities. The consultation was considering two proposals (1) reforming the enforcement of the Nutrition and Health claims Regulations 1924/2006 in England by introducing an improvement notice regime and (2) revoking approximately 60 pieces of tertiary legislation regarding decisions to either reject claims or to modify the list of approved claims recorded in Regulation EU (No) 432/2012.
- FSA: Proposals for establishing a new framework in England under the Genetic Technology (Precision Breeding) Act 2023 for the regulation of food and animal feed ('feed') produced from Precision Bred Organisms (PBOs) ('PBOs for food/feed').

Supporting stakeholder networks

Food Authenticity Network

The Food Authenticity Network (FAN) is an open access interactive website that shares best practice information on food authenticity testing, food fraud mitigation and food supply chain integrity, helping to better protect the global food supply and ultimately improving consumer confidence in food.

2023 was another busy year for FAN. The website content was developed further to include new government reports, the FSS Food Crime Risk Profiling Tool, the International Atomic Energy Agency (IAEA) Chemometrics Training Tool and a Protocol for collection of reference honey samples. FAN also launched the output of one of its Partner Projects, a new Authenticity Database search tool, which currently includes 218 databases.

The FAN Team contributed to many conferences/meetings including: the Codex

Committee on Food Import and Export Inspection and Certification Systems (CCFICS), the technical round table on honey at the European Commission’s Joint Research Centre, the SSAFE board meeting, and the Food Integrity conference and Food Ingredients Europe 2023.

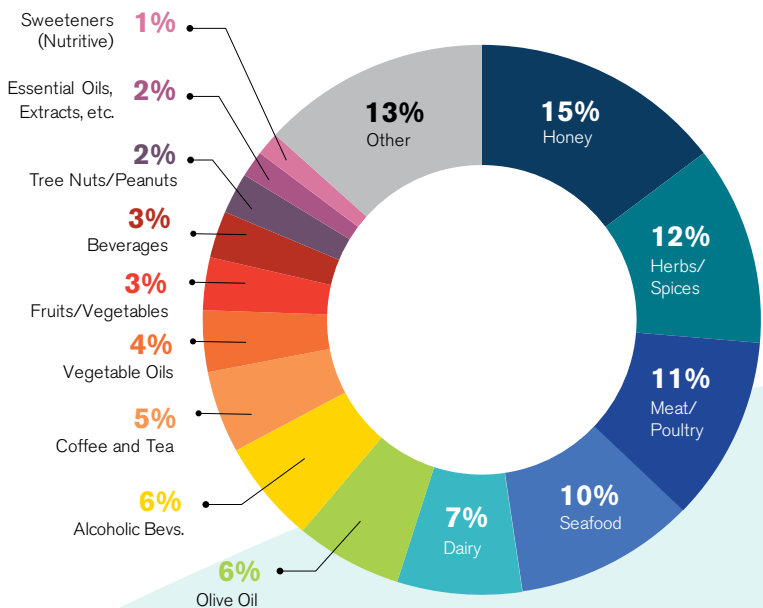
Interaction with Members remains a key component of FAN’s strategy; in 2023 a member survey was conducted. The results showed that members are very likely to recommend FAN to a colleague and that over 85% of respondents find the FAN monthly summary and resources on the FAN website very useful. The number of visits to the website continues to grow with over 43,000 unique visitors from 166 countries in 2023.

The 2023 FAN Summary is being produced in Chinese, English, French and Spanish this year to account for the growing global audience.

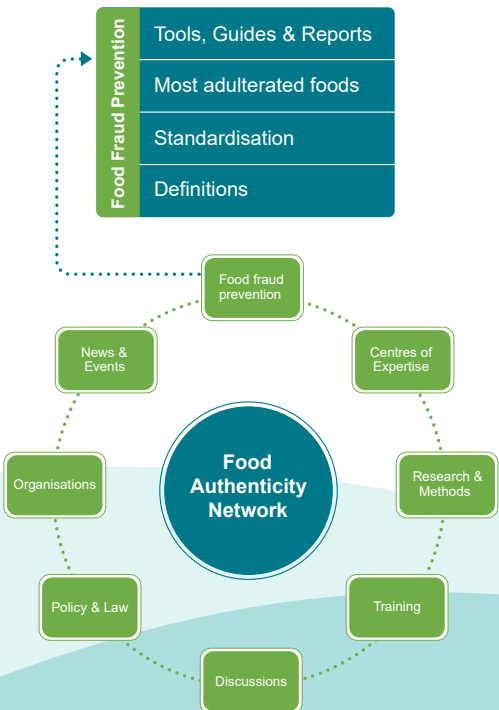
Most Adulterated Commodities 2023

(percent of total records) Global data 2023

Source: [FoodChain ID Food Fraud Database](#)



Over 43,000 unique visitors from 166 countries in 2023





**Collaboratively
building a resilient
national skills base**



The Government Chemist has a long history of supporting and underpinning the skills base across the UK through dissemination and collaborative training. The Government Chemist maximises the impact of the capability developed through the programme by efficient and timely dissemination, building on existing initiatives and proactively developing new collaborative opportunities, nationally and internationally.

Building networks

Food Authenticity Centres of Expertise – framework for a coordinated response

The Food Authenticity Network has worked with Defra, FSA, FSS, National Food Crime Unit (NFCU), Scottish Food Crime and Incidents Unit (SFCIU) and the Food Authenticity Centres of Expertise to agree a framework for a co-ordinated response from food authenticity Centres of Expertise (CoE) to national or international food and feed fraud incidents and/or investigations.

Responding to food and feed fraud incidents typically requires capabilities that might not be limited to one singular laboratory. In recognition of this, it was envisaged that a virtual network of CoEs would function in a similar way to a National

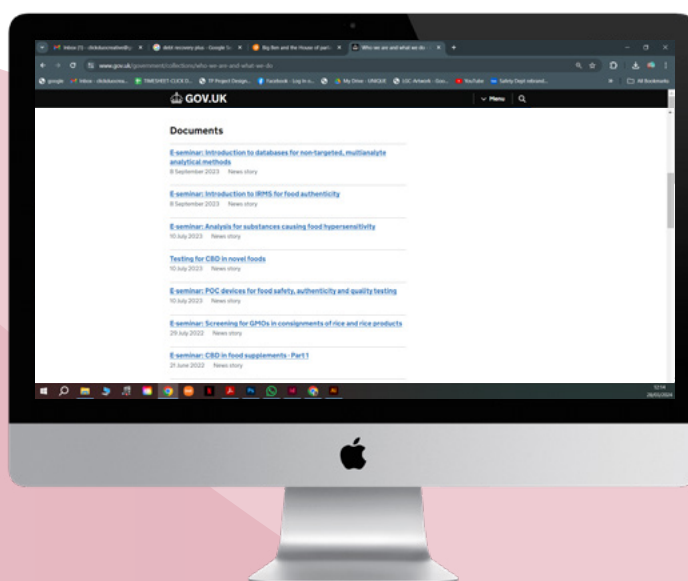
Reference Laboratory by helping to ensure that authenticity testing methods employed are fit for purpose and offering expert advice to the food authenticity analytical community as required.

Knowledge dissemination

Joint Knowledge Transfer activities

The Joint Knowledge Transfer (JKT) framework is aimed at sharing knowledge from government-funded research to stakeholders, to support UK laboratory capability and best practice in food safety and standards analysis via dissemination activities. The activities are agreed with the funding partners Defra, FSA, FSS, and DSIT, via the Government Chemist. The programme of work is delivered by the Government Chemist team working with external experts as required.

During 2023 the following activities were delivered and published under Resources on the Government Chemist website (<https://www.gov.uk/government/collections/knowledge-resources>).



E-seminars

Introduction to Isotope Ratio Mass Spectrometry (IRMS) for food authenticity.

An introduction to the application of IRMS for use with food authenticity and quality testing.

Analysis for substances causing food hypersensitivity.

An introduction to food hypersensitivity, food allergens, gluten and food intolerance compounds.

Point of Contact (POC) devices or food safety, authenticity and quality testing.

An overview of POC testing, range of analytical techniques and examples of current and emerging devices for use with POC testing.

Webinars

Screening for GMOs in consignments of rice and rice products originating from China.

Dr Timothy Wilkes gave a presentation on screening for GMOs in consignments of rice and rice products imported from China. This was followed by a Q&A panel with experts from LGC. The webinar was chaired by Selvarani Elahi.

Testing for CBD in novel foods. Paul Tossell (FSA) outlined the agency's position regarding regulation of cannabidiol (CBD) and Tabatha Hambidge (LGC) provided an overview of the analysis of novel foods for the presence of CBD. The webinar was chaired by Selvarani Elahi.

MChemA training

As part of the FSA training contract, a three-day residential course was held at the University of Birmingham from 12-14 December. 15 people attended the workshop, a mix of MChemA candidates and staff working in official control laboratories. The course covered topics such as food microscopy, food labelling, agriculture and food microbiology. An interactive session was also held, where one of the MChemA candidates took the stand and was cross examined in a mock courtroom scenario.

The course was very well received with candidates appreciating the in-person event giving opportunities to network and discuss progress with their studies and have requested similar courses as they progress through their studies.

The support of the University of Birmingham is recognised in hosting this course, as is the financial support from the FSA.





Government Chemist Conference

The Government Chemist Conference 2023, 'Safe food for tomorrow's world – food security in challenging global conditions' was hosted on 20-21 June at the Royal Society of Chemistry, Burlington House, London. It was the first time in five years that colleagues and stakeholders in the field were able to get together in person to discuss challenges and opportunities in ensuring global food security, authenticity, safety and sustainability.

The conference was attended by over 100 people in-person and 30 people online from organisations in government, industry, law enforcement and academia. Feedback was very positive; 100% of respondents stated that they would recommend attending Government Chemist events.

The conference was opened by Henry Dimbleby who gave a keynote lecture reflecting on the state of the UK food system and the challenges we must address for a healthy population. The conference sessions focussed on the themes of 'Authentic and safe food', 'New and emerging technologies' and 'Solutions to challenges in food production' and included a second Keynote talk by Professor Guy Poppy on transforming the UK food system through the application of science.

During the event, conference attendees were able to explore and discuss the many global threats and challenges facing the UK food system, considering the current geopolitical, environmental and economic conditions. Whilst the overview might have appeared bleak, the conference provided insight into possible solutions and mitigation tools to help ensure safe food for the future.

Publications

The effect of roasting on boron isotope ratio in coffee beans: Implications for provenance studies of roasted coffee. <https://doi.org/10.1016/j.foodchem.2023.138128>

Clinically and industrially relevant incurred reference materials to improve analysis of food allergens milk, egg, almond, hazelnut and walnut. <https://doi.org/10.1016/j.foodchem.2023.137391>

Detection of food and feed plant products obtained by targeted mutagenesis and cisgenesis <https://data.europa.eu/doi/10.2760/007925>



**Maximising UK
measurement expertise to
address global challenges**





The Government Chemist Programme aims to extend and grow links with the scientific community, partner organisations and the government departments across the four nations of the UK, in order to enhance and future-proof existing capabilities and maximise collaborative synergies between stakeholders to address global challenges.

Capability building projects

The capability building projects delivered in each programme are prioritised to address key drivers identified in consultation with stakeholders at regular intervals. This activity is complemented by the participation in committees, working and expert groups and in actively seeking to collaborate in projects involving stakeholders across government department industry and academia.

The breadth of knowledge generated through the Government Chemist's advisory function – and disseminated through to government, European Commission and wider stakeholder communities – provides a secure scientific basis for more efficient and cost-effective regulations. This is achieved by translating current capabilities into timely support and advice, by generating chemical and bio-measurement solutions for its own referee case use and for adoption by stakeholders, and by predicting future regulatory issues.



Inorganic arsenic in rice

One fifth of food consumed worldwide is rice. Inorganic arsenic forms around 40-70% of arsenic present in rice. However, this form is more toxic than organic forms and can have carcinogenic and damaging effects on human health. In order to avoid these effects, in 2016, the European Commission Regulation published a maximum inorganic arsenic concentration level that is permitted in rice products.

Building on a previous project within the Chemical and Biological Metrology Programme funded by DSIT, the Government Chemist Programme extended the capabilities of SI traceable methodology for inorganic arsenic in rice to more complex baby-rice matrices as listed by the European Commission Regulation.

To assure national capabilities, the Government Chemist coordinated an inter-laboratory comparison for official laboratories to test measurement capabilities for inorganic arsenic in food and feed products. Baby-rice reference materials were value assigned and were provided for all participants.

Results from the inter-laboratory comparison confirmed capabilities for determining total and inorganic arsenic level in rice and rice products across official laboratories.

The Government Chemist's improved methodology for the SI traceable measurement of inorganic arsenic can now be applied to commercially sourced complex rice matrices such as rice cakes, crackers and crispies, giving the Government Chemist extended capabilities for future inorganic arsenic referee cases.

Genome editing

Modern genome editing techniques can facilitate addition, removal, or alteration of DNA sequences at specific locations in the genome. These alterations can vary from single nucleotide variations (SNVs) to deletions and insertions of many base pairs. In 2018, the European Court of Justice ruled that products of genome editing should be regarded as Genetically Modified Organisms (GMOs) and fall under the pre-existing legislation for detection and labelling of GMOs. Since this period, and EU exit, the UK passed the Genetic Technology (Precision Breeding) Act in March 2023, which excludes some genome edited organisms from the regulatory definition of a GMO.

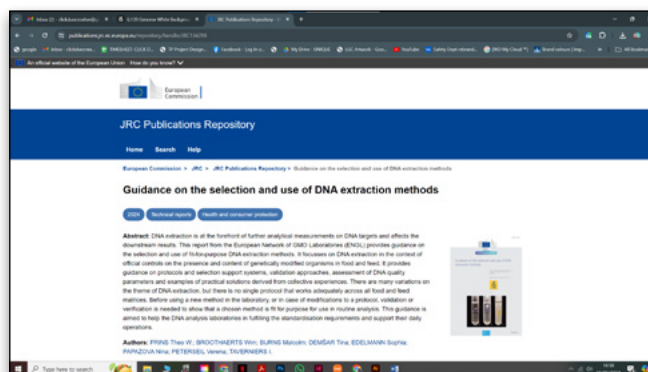
Products resulting from genome editing, being subject to different classifications under separate regulatory regimes, may provide several analytical challenges to ensure full traceability. There are significant challenges in agreeing an infrastructure for the detection of genome edited products. Continued development and understanding of new molecular biology-based approaches augmented through additional traceability tools, coupled with agreement on best measurement practice guidance, is key in addressing these challenges.

The Government Chemist team has been working to further enhance its practical expertise in the application of GMO analytical approaches to assess compliance with relevant UK legislation, and to future-proof the advisory and referee function in relation to GMOs and Precision Bred Organisms (PBOs).

In order to demonstrate competency, the team has completed a number of GMO Proficiency Test rounds where it has received compliant z-scores, including two complex samples consisting of mixed flours and processed matrices. As part of a recognised external quality assessment exercise, these results contribute towards maintenance of ISO/IEC 17025 flexible scope of accreditation for GMO analysis.

In his role as Senior Advisor and Head of the GMO analytical unit, Malcolm Burns provided input into several published documents.

EC-JRC/ENGL technical guidance document on selection and use of DNA extraction methods <https://publications.jrc.ec.europa.eu/repository/handle/JRC134298>



EC-JRC/ENGL technical guidance document on method performance requirements, inclusive of performance parameters for methods for detection of genome edited products. <https://data.europa.eu/doi/10.2760/63656>

EC-JRC/ENGL technical guidance document on detection of food and feed plant products obtained by targeted mutagenesis and cisgenesis <https://data.europa.eu/doi/10.2760/007925>



FSA project FS616029 'Literature review on analytical methods for the detection of precision bred products' <https://doi.org/10.46756/sci.fsa.ney927>

Events

Government Chemist staff organised and chaired one of the regular UK GM network meetings, which was attended by representatives from LGC, Fera and SASA (Science & Advice for Scottish Agriculture). These meetings are designed to share best measurement practice guidance, discuss topical issues related to GMOs and genome edited products, identify analytical gaps and horizon-scan for any emerging issues in the UK.

Malcolm Burns gave several presentations on GMO related topics:

- A presentation entitled 'Traceability of genome edited products in the food supply chain — Status and challenges', at the 2023 Government Chemist conference. The presentation outlined some of the current challenges and status of using molecular biology approaches for detection and traceability of genome edited products and organisms in the food supply chain. The talk provided recommendations and opportunities which could be capitalised upon in order to further develop an infrastructure for traceability in the food supply chain, in this rapidly evolving area.
- A presentation for CCQM (Consultative Committee for Amount of Substance: Metrology in Chemistry and Biology) as part of the World Metrology Day 2023 event, focused on the status and challenges in detecting GMOs and genome edited products.
- The initial technical presentation as an invited expert at the International Conference on GMO Analysis and New Genomic Techniques in March 2023, held in Berlin, Germany. The conference provided a forum to promote technical and scientific exchange between scientists worldwide on the status and challenges for traceability, detection and identification of GMOs and genome edited products.





Input into committees – committee membership

The Government Chemist has continued to contribute to national and international committees to ensure the establishment of legislation, standards and policy that are relevant and contain references to measurement practice that are fit for their intended purpose. The list of committees the Government Chemist team contribute to is available under the membership section in www.gov.uk/governmentchemist. Notable contributions in 2023 are highlighted below.

Selvarani Elahi has been part of Shield Safety Group's Safe to Trade Scheme Independent Governance Board (IGB) since 2020 and was invited to Chair the Scheme's new Impartiality Committee from 2024. The Impartiality Committee is required to address the requirements of UKAS accreditation to ISO 17065:2012 – Conformity assessment – Requirements for bodies certifying products, processes and services.

Government Chemist staff have inputted into various CEN/TC 460 (Food Authenticity) meetings:

- Inter-working group exchange between Convenors and Secretaries;
- Working Group 1 – Food fraud definitions, where comments on the standards were reviewed;
- Working Group 8 – HADH method to detect previously frozen poultry, where the first meeting was held with five country representatives and a decision was made to progress this work item to a formal ballot.

Engagement with stakeholders

In addition to the regular participation on the advisory committees, the Government Chemist organises and is invited to contribute to a number of events organised by stakeholder organisations. Some of the key stakeholder engagements are listed below.

- Staff from the OPSS visited LGC, providing an opportunity for each organisation to discuss common areas of interest. The OPSS staff were also taken on a laboratory tour.
- At the BRCGS Leaders of Tomorrow Webinar, Selvarani Elahi gave an account of her personal career journey and answered questions from the audience. The event attracted a global audience of over 650 people from 60 countries.
- Jasmine Lacis-Lee, President of the Allergen Bureau, visited LGC and was introduced to the teams within the NML undertaking work on food allergens.
- Selvarani and Paul Hancock attended the parliamentary reception for the FSA and FSS launch of a new assessment of UK food standards.
- Selvarani attended Food Ingredients Europe 2023 (the world's largest gathering of food and beverage ingredient buyers and suppliers with approximately 125,000 people attending daily) to participate in a panel discussion titled 'Can we win the fight against food fraud?' She also attended the early morning women's breakfast networking event and heard insights from some leaders in the food industry.



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