Government Chemist

Review 2021

Department for Business, Energy & Industrial Strategy

FUNDED BY BEIS

Contents

"Ensuring the security and health of our future food system"

Foreword from the Government Chemist

The last two years have highlighted most sharply how closely human and animal health are interrelated, often through the environment in which they interact. The restrictions brought upon our complex food systems by the COVID-19 pandemic have led to observable shifts in food availability and safety, and human nutrition and health; especially in our most vulnerable communities. More indirect consequences of the pandemic, crucial to food security, will take time to emerge fully. It is therefore essential that we continue to review the lessons learned from this pandemic in preparation for future outbreaks and their associated threats.

The UK regulatory regime has evolved over this same period, following the initial position of retained EU law for food and feed safety and hygiene, agreed as part of the Transition Period following the withdrawal of the UK from the EU.

A number of the current activities of the Government Chemist Team described in this Annual Review reflect the consequences of these emerging themes. Looking ahead, these themes will most likely shape the formulation of the priorities for the next Government Chemist Programme (2023-2026).

This year, the statutory function of the Government Chemist has seen a significant resurgence in disputes requiring referee analysis. The challenge of processing a large number of similar referee cases relating to genetic modification of certain product types, received over a short time period, certainly tested the Government Chemist Team, as we worked in shifts onsite and remotely to meet government guidance on social distancing. Only through the understanding of our customers, and the experience and delivery of all the scientists supporting the Government Chemist role were we able to meet this high demand and maintain the highest scientific levels expected.

We also managed to enhance our resilience and future proof our ability to respond to such challenges, whilst continuing our work with Government to strengthen the capacity and analytical capability within UK enforcement laboratories and, indeed, food business operators (FBOs) around these products.

I have also welcomed especially the increased recognition of the advisory and broader technical contributions of the Government Chemist Team to several departmental and strategic cross-departmental issues.

We were able to feed the outputs of our cannabidiol (CBD) studies into the Advisory Council on the Misuse of Drugs (ACMD) to help them specify which cannabinoids should be controlled and the unavoidable trace levels for each of these within consumer CBD products. I was pleased especially to note recognition of our interlaboratory study in the published ACMD report for "providing the main evidence for the practical capacity for the analytics industry to test" for such products. The Government Chemist Team will continue to work with UK regulators and other stakeholders to help take the ACMD's recommendations forward.

The Government Chemist team is continuing to work with government departments to identify the tools, standards and guidance needed to facilitate effective testing for honey fraud, and allow enforcement of food standards and protection of consumers and legitimate businesses. E-seminars, and work standardising a protocol for the sampling of authentic samples and establishing a framework for the scrutiny of authenticity databases is planned.

Government Chemist support was also provided to the production of the guidance note focusing on the use of next-generation sequencing (NGS) for food authenticity testing.

Meanwhile, extension of the impact of the Government Chemist function has continued with the ongoing growth in jointly-funded cross-government (Defra/FSA/FSS/Government Chemist) Knowledge Transfer Programme activities. In particular, the Food Authenticity Network (FAN) was commissioned to undertake an examination of the published literature to identify the major definitions related to food fraud and global standardisation activities in this area (with a focus on terminology and testing methods). The published Defra UK Food Security Report featured the FAN as a case study. I remain confident therefore that the ever-increasingly visible outcomes highlighted in this Annual Review represent significant steps forward for the Government Chemist role so that it is positioned perfectly to meet not only its existing but future obligations for Government and the food and feed sector as a whole.

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

Note from the Chair of the Government Chemist Programme Expert Group

For the second year running I feel obliged to refer to the extraordinary nature of the last year. During 2021, the world continued to be constrained by the COVID-19 pandemic, with restrictions affecting every aspect of life. However, observing the steady improvement that both diagnostic and vaccine development brought to health and safety outcomes has reinforced how much we need world-class scientific research and innovation capabilities to face future challenges successfully.

The Government Chemist and his team have long understood the need to be prepared to be called upon to discharge their duties as a referee analyst or advisor for wide-ranging food and feed safety and authenticity issues. However, not often are they asked to do so under such circumstances and, during this past year, so frequently! Despite this, there has also been the increasing recognition of the impact of the Government Chemist on many aspects of the food and feed regulatory framework, for example, through contributions to the Advisory Council on the Misuse of Drugs (ACMD) report on CBD, the IFST food allergens resource, the FSA food hypersensitivity research horizon scanning exercise, and through participation in over 25 national and international committees.

The biennial Government Chemist conference is usually a great excuse to bring stakeholders together for a couple of days, full of interesting talks and networking opportunities. Unfortunately, the 2020 conference had first to be postponed and then to be delivered online in 2021. Whilst the opportunity to interact meaningfully was missed greatly, it provided an exceptional occasion for stakeholders from all over the UK and beyond to participate in the event. Attended by over 240 people at some points, the conference programme offered an overview of the challenges and opportunities in providing safe, authentic and sustainable food from multiple angles, including UK government departments, academia, industry, trade organisations and local authorities. While it is safe to say that the talks and discussion provided information and answers to some questions, it also raised some new ones for the future.

The Programme Expert Group (membership is detailed in page 6) continued to meet virtually during 2021 to offer BEIS independent oversight of the progress and impact of the Government Chemist function. During these meetings we were able to scrutinise the distinct projects within the overall work programme and to hear first-hand from the scientists delivering the results of referee cases, the beneficiaries of the outputs of the programme and the innovative approaches and solutions being adopted to ongoing measurement challenges. These meetings are unfailingly intense and thought-provoking, and bring to mind the complex framework built around the very basic need for ensuring safety, determining origins or verifying authenticity. This reminds us of the importance of the work we are all doing to secure the right of being able to place our trust in the food that we eat.

I hope that we will progress steadily towards a safer world in 2022, perhaps with increased interaction and not just through screens. But I also hope that we build on what we learned in the last two years and continue adding to the great pool of scientific and evidence-based knowledge, to help us overcome the challenges the future throws our way.

Professor Paul Berryman
BSc, MSc, MChemA, MBA, PhD, CBiol FRSB, CSci FIFST, CChem FRSC.

1

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 Business, Energy and Industrial Strategy (BEIS).

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.

Our statutory function

The Government Chemist's statutory function comprises science-based duties prescribed in several acts of Parliament which are listed in the "About us" section of the Government Chemist website (www.gov.uk/government/organisations/government-chemist/about). 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 spillover 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 (NML) for chemical and bio-measurement at LGC.

► **Section 3 looks at the year's completed referee cases.**

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; 2021 consultation responses have been listed on page 18.

► **See Section 4 for more about the wider advisory function.**

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. The Government Chemist Programme carries out capability-building projects to be prepared for demand for referee analysis in these areas.

► **Section 5 provides an overview of our current capability-building activities.**

Our governance

Responsibility for the Government Chemist programme lies with the International Research and Innovation Directorate at BEIS.

BEIS 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 quality of impact of the programme, and offering advice to BEIS 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 in 2021

Paul Berryman, Chair

Paul is the Director of Berryman Food Science Ltd, which works closely with government and businesses, including the Department for International Trade (DIT), Innovate UK and SGS Ltd. He is also a visiting Professor at the University of Reading.

Robbie Beattie

Robbie is the Public Analyst, Agricultural Analyst and Food Examiner to nine local authorities in Scotland. As a senior manager with The City of Edinburgh Council he manages a portfolio of income generating assets.

Simon Branch

Simon is Director of Research, Development and Scientific Affairs at Herbalife and has sat on a number of committees including the RSC Science and Technology Board.

Keneth Chinyama

Keneth works for the Food and Drink Federation in the Food Science and Safety Division. Keneth is responsible for scientific and regulatory issues, particularly on residues and contaminants and regulated products including food additives, flavourings, enzymes and plant protection products.

Andrew Damant

Andrew is an official UK delegate on numerous international committees and an advisor to various UK committees. Andrew retired from the Food Standards Agency (FSA), where he led the Surveillance, Methods and Laboratory Policy Team, in 2018.

Lucy Foster

Lucy is the Programme Manager for food chain research at Department for Environment, Food & Rural Affairs (Defra) having previously worked at the FSA.

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, allergens, foodborne viruses and surveillance at Food Standards Scotland (FSS).

Chelvi Leonard

Chelvi is Policy Lead for Accreditation at the Office for Product Safety and Standards (OPSS), BEIS. 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, based at the port of Felixstowe. Brenda currently leads on imports of fishery products and is also involved with the import of foodstuffs of non-animal origin.

Declan Naughton

Declan is currently Professor of Biomolecular Sciences at Kingston University London with research interests spanning food safety, nutrition, natural products, performance enhancing drugs, inflammation, drug discovery and endocrinology. He is also Interim Dean and Associate Dean for Research and Enterprise for the Faculty of Science, Engineering and Computing at the university.

David Pickering

David is the 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 Focus group.

Sophie Rollinson

Sophie is the food science lead in Defra's Food and Farming Directorate and manages the Department's Food Authenticity Research Programme.

Diane Turner

Diane is the Director and Senior Consultant of Anthias Consulting Ltd, an independent provider of analytical training and consultancy. Diane has developed methods for and given support to companies in most industries around the world for the past 20 years. She is a visiting academic and consultant at The Open University where she continues her disease diagnosis research from her PhD plus food, drug and space applications. Diane is President of the Royal Society of Chemistry Analytical Division Council and Chair of the Analytical Chemistry Trust Fund.

Roger Wood OBE

Roger is an experienced food analysis specialist, formerly a senior scientist in FSA. Roger has represented the UK at numerous EU methods of analysis and sampling working groups in the food and feed sectors over many years and has been Chair of a number of international food analysis working groups.

Julian Braybrook
Government Chemist
Julian.Braybrook@lgcgroup.com

Selvarani Elahi MBE
Deputy Government Chemist, Nominated Officer
Selvarani.Elahi@lgcgroup.com

John Black
Programme Manager
John.Black@lgcgroup.com

Michael Walker
Consultant Referee Analyst and Nominated Officer, retired end March 2021

Paul Hancock
Head of the Office of the Government Chemist, Referee Analyst, Nominated Officer,
Paul.Hancock@lgcgroup.com

Malcolm Burns
Head of GMO Unit and Principal Scientist
Malcolm.Burns@lgcgroup.com

Steve Ellison
Experimental Design and Statistical analysis
S.Ellison@lgcgroup.com

Simon Cowen
Statistical Analysis Team Leader
Simon.Cowen@lgcgroup.com

Kirstin Gray
Analysis Manager
Kirstin.Gray@lgcgroup.com

Figure 1 Government Chemist organogram and contact points

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.

Selvarani Elahi, Deputy Government Chemist and Business Manager, Food Research, LGC, was awarded an MBE for services to Food Measurement Science in the Queen's Birthday 2020 Honours List. Selvarani received her MBE from HRH Princess Anne during a ceremony at Windsor Castle.

Selvarani Elahi was appointed Deputy UK Government Chemist in 2011, having worked for over 25 years in the analysis of food and agriculture samples and across a variety of policy areas, with different stakeholder groups both nationally and internationally, to improve standards in measurement science.

Selvarani has been the Chair of Defra's Food Authenticity Analytical Methods Working Group since 2013 and is also the Executive Director of the Food Authenticity Network.

2

In focus
Agricultural resilience for the future

By Darshna Vyas,
Senior Scientist,
Genomics, LGC

The Coronavirus disease (COVID-19) pandemic has changed the world as we know it and impacted the lives of every human on earth. This turbulence can be seen as a precursor to the challenges that will be faced as the global population increases and the climate continues to change. An area of acute imbalance is that of food production and the demand for food. It has been estimated that the number of people facing a food crisis grew from 135 million to 265 million by the end of 2020 (Anthem, 2020)[1]. Developing agricultural resilience is therefore a necessity, not a choice.

Modern plant breeding management practice advances have contributed substantially to the current annual gain of 0.8–1.2% in crop productivity. Nevertheless, this current rate of improvement is not sufficient to keep up with food and biofuel demands for the projected global population in 2050 (D.K. Ray et al, 2012)[2]. Advancements in genomic technologies are crucial to help mitigate this challenge and need to achieve >2% global genetic gain to accommodate global population growth and climatic changes. Other factors required for progression are:

- leveraging technology innovation;
- establishment of food research hubs and partnerships;
- finance for small and medium collaborations;
- transformations in the food and agriculture sector to build resilience;
- diversification of cropping systems;
- use of Artificial Intelligence (AI) and machine learning to improve precision of selection processes.

In the last 20 years genomic technologies have evolved rapidly. The advent of high-throughput technologies such as next-generation sequencing and ultra-high-throughput (uHTP) workflows have enabled step changes in breeding strategies, which have contributed considerably to varietal development. Current technologies and future methodologies that may help alleviate this crisis are discussed in this article.

Marker assisted selection (MAS) and genomic selection (GS)

MAS is an approach that uses single nucleotide polymorphisms (SNPs) present in DNA as an indirect selection method for physical traits in plants and animals. This method saves time and effort in the selection of plants to take forward in plant breeding programs. The number of SNPs or markers used in genotyping for MAS are regarded to be a low-resolution assessment of target traits and genomes.

To achieve the genetic gains necessary for continued agricultural sustainability required a revolution in the strategic development of breeding pipelines. GS provides high-resolution sequence-based genotyping and has been applied extensively to livestock breeding programs to accurately predict and select livestock where investment needs to deliver maximum genetic gains. In wheat breeding, multifamily GS could increase genetic gain per unit time and per unit cost by greater than two- to three-fold (E.L Heffner et al, 2011)[3].

[1] Anthem, P. (2020). Risk of hunger pandemic as COVID-19 set to almost double acute hunger by end of 2020. World Food Program Insights https://insight.wfp.org/covid-19-will-almost-double-people-in-acutehunger-by-end-of-2020-59df0c4a8072.

[2] Ray, D.K. et al. (2012). Recent patterns of crop yield growth and stagnation. Nat. Commun. 3:1293 doi: 10.1038/ncomms2296.

[3] Heffner, E.L., Jannink, J., Sorrells, M. E., (2011). Genomic selection accuracy using multifamily prediction models in a wheat breeding program. The Plant Genome 4:65–75. 16 Mar. 2011. doi: 10.3835/plantgenome2010.12.0029.

CRISPr/CAS

The ability to select and control site-specific mutations in plant genomes through CRISPr/CAS and other repair mechanisms is revolutionising the introgression of important agronomical traits. Current limitations of mutation rates and regulatory constraints for this technology restrict the scope of this application but expected developments and clarity of regulations will ensure that CRISPr/CAS remains significant for future agricultural sustainability objectives.

Ultra-high-throughput (uHTP) soil/plant pathogen testing

Soil and plant pathogen testing protocols remain profoundly underdeveloped. The instigation of uHTP screening for global SARS-CoV-2 monitoring has established a new area of science: the surveillance of RNA virus pathogens. If uHTP workflows were to be applied to the detection of pathogens in soils or on plants, potentially thousands of pathogens could be monitored and detected early through surveillance. Assurances of certified virus-free seed or vegetative stocks could be provided to farmers, thus aiding the control and spread of viruses, and eventually having the potential to eliminate virus reservoirs in agricultural land and surrounding areas.

Epigenetics

Epigenetics is the study of heritable changes in genome function that are not associated with DNA sequence alterations. DNA methylation is the control mechanism which alters gene expression and enables physiological changes to be made. Epigenetics pathways are reported to produce phenotypic plasticity in plants which enables them to survive and reproduce in erratic ecosystems (Pikaard, 2014)[4]. Both long non-coding RNAs (lncRNA) and small interfering RNAs (siRNA) have been shown to influence epigenetic modifications for adaptation. The development and application of epi-allele marker selection will provide targeted assisted selection of a new bank of markers which, when combined with genomic markers, could see the development of new varieties based not only on genotype but also how those genotypes behave in a particular environment.

Speed breeding

Speed breeding is a method by which the development of plant varieties is accelerated through the reduction of plant generation times. Control of circadian rhythms is achieved by modification of the photoperiod and temperature under controlled environments. Essentially, the adjusted conditions persuade plants to believe an hour is a single day. Application of speed breeding for wheat trait introgression has enabled six generations of wheat to be grown in a period that would normally only allow a single growth cycle (Watson et al, 2018)[5].

[4] Pikaard, C.C. and Mittelsen Scheid, O. (2014) Epigenetic regulation in plants. Cold Spring Harb Perspect Biol 2014;6:a019315.

[5] Watson A, Ghosh S, Williams MJ, et al (2018) Speed breeding is a powerful tool to accelerate crop research and breeding. Nat Plants. doi: 10.1038/s41477-017-0083-8.

AI and machine learning: smarter farming

The application of AI and machine learning for agricultural sustainability is still in its infancy, yet it holds huge potential. This novel approach provides plant breeders with the capacity to predict in fine detail the variation that lies unutilised using conventional selection processes. For effective utilisation of AI in plant breeding collaboration, especially across the different -omics technologies, will be key.

In-field plant genotyping

The development of in-field plant genotyping is a concept that could radically change varietal screening. The approach would reduce time, cost and environmental consequences when compared to current process flows. Targets for initial implementation could be selection for trait-specific makers. In-field plant genotyping would require a novel perspective on potentially suitable chemistries (e.g. Kompetitive allele specific PCR, High resolution melting, Loop-mediated isothermal amplification) to ensure feasibility.

Carbon sequestration in agriculture

Plants absorb carbon dioxide and release oxygen as part of normal photosynthetic pathways. This natural ability is the concept that underlies the SALK Institute's Harnessing Plants Initiative[6]. The sequestering of carbon into root biomass provides a means to achieve global scale reduction in carbon dioxide with the simultaneous potential to increase genetic gain. The inclusion of trait-specific targets such as increased root length and mass for all agronomic crops grown globally could tip the balance in our favour and lead to a negative carbon impact.

Summary

New technological approaches and the application of existing chemistries have the potential to turn the tide for achieving agricultural sustainability. Improving varietal development through increasing biotic and abiotic resistance, and ultimately genetic gain, will impact not only food supply for future generations but could also mitigate the impacts of climate change.

[6] Harnessing Plant Initiative https://www.salk.edu/harnessing-plants-initiative/.

3

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 2021

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 statutory conditions for referral usually begin with either the contemplation or commencement of legal proceedings where the prosecution intends to offer analytical evidence, or rejection of imported goods at point of entry. As the restrictions around COVID relaxed, an increase in enforcement activity resulted in an upturn in the number of cases received, all being in the second half of the year. A total of 11 cases were received, compared to seven in 2020.

The workload was dominated with eight cases on disputes around GMOs in rice or rice products originating from China. The three remaining cases focused on the presence of a pesticide in an organic peanut product, aflatoxin in dried figs and the final case was a request to interpret scientific data around the structure of a liposomal product.

GMO

EU law[7] prohibits the placing on the market of genetically modified (GM) food or feed unless it is officially authorised and provides for its labelling and supervision. Authorisation is only granted after demonstration that the GM food or feed does not have adverse effects on health or the environment, it does not mislead the consumer, and a validated method is available for its detection. In addition, the GM food must not differ from the food it is intended to replace to such an extent that its normal consumption would be nutritionally disadvantageous.

There are currently no genetically modified rice or rice products authorised in the UK. From 2006 onwards, some rice products originating in, or consigned from, China were found to be contaminated with the genetically modified rice Bt-63. The Chinese authorities took steps to control the presence of GM rice, but GM varieties such as Bt-63 and others continued to be found.

As a consequence, the EU requires rice imports from China to be accompanied by an analytical report demonstrating the absence of GM rice. From December 2011 all rice imports from China have been subject to inspection, sampling and analysis. Owing to the lack of detail of the full DNA sequences of genetically modified rice varieties available in China, a screening approach is adopted for certain generic genetic elements. Generally, GM plants are produced by inserting a transgenic sequence that encodes for a desired trait into the host genome. The trait sequence is typically bounded by regulatory promoter and terminator sequences, some of the most common being the 35S promoter (P35S) (derived from Cauliflower Mosaic Virus (CaMV)) and the nopaline synthase terminator (TNOS) (derived from Agrobacterium tumefaciens). Thus, P35S and TNOS are useful screening targets. Further screening targets are genes encoding for the Bacillus thuringiensis endotoxin Cry1Ab/Ac, genetically engineered as an insect resistance trait sequence.

The Government Chemist received eight cases for GMO analysis during 2021, the increased number attributed to the reduction in the capacity and capability of UK labs since 2019, and also mirrored by an upturn of positive cases being reported on by the EU. This reduction resulted in more requests for second expert opinion and highlighted that some labs are not offering the full prescribed testing regime leading to dispute. We completed six of the referee cases (see Table 1 for a summary of the cases) with two cases still in progress at the time of writing.

The analytical approach we used for the quantification of GMOs is described in detail in the Government Chemist Review 2017 (p18).

Table 1: Summary of GMO cases completed in 2021

Case	2023-8	2023-9	2023-10	2023-11	2023-12	2023-15
Food type	Instant rice meal	Rice noodles	Rice noodles	Rice cakes	Short grain rice	Rice vermicelli
Disputed GM element	Cry1Ab/Ac	Cry1Ab/Ac	Cry1Ab/Ac	Cry1Ab/Ac	CaMV-35S	Cry1Ab/Ac
Government Chemist findings	GM not detected	Cry1Ab/Ac detected	GM not detected	GM not detected	T-NOS detected	Cry1Ab/Ac detected
Outcome	Consignment allowed entry into UK	Consignment not allowed entry into UK	Consignment allowed entry into UK	Consignment allowed entry into UK	Consignment not allowed entry into UK	Consignment not allowed entry into UK

[7] Regulation (EC) No 1829/2003 of the European Parliament and of the Council of 22 September 2003 on genetically modified food and feed https://eur-lex.europa.eu/eli/reg/2003/1829/2008-04-10

Organic peanuts – presence of pesticide residue

The case, referred by the food business operator, revolved around the presence and level of a residue of the pesticide thifluzamide in a product described as organic peanuts.

The residue was analysed by LC-MS/MS with a QuEChERS (Quick, Easy, Cheap, Effective, Rugged Safe) extraction regime tailored for pesticide analysis. Eight mass spectrometric transitions between precursor and product ions were available to confirm the identity of any thifluzamide residue present, along with appropriate retention time windows and other prescribed criteria for identification. Matrix standards were also employed to allow for matrix effects. The analysis proceeded as two separate batches, with appropriate quality control which included spike samples, blank samples and multiple replicates.

A total of 12 results were obtained for the dispute sample, thifluzamide being detected at a mean concentration of 0.0091 ± 0.0028 (expanded uncertainty at 95% confidence level) mg kg^{-1}. The presence of thifluzamide was confirmed using GC-MS.

There is no specific limit set for thifluzamide in peanuts, as prescribed by Retained EC Regulation 396/2005 *on maximum residue levels of pesticides in or on food and feed of plant and animal origin*, and therefore the default limit of 0.01mg kg^{-1} applies. The mean amount found was below this level, and therefore the sample was deemed compliant with this Regulation.

The sample was described as 'Organic'. Retained EU Regulation 834/2007 *on organic production and labelling of organic products* in conjunction with retained EU Regulation 889/2008 *laying down detailed rules for the implementation of EU Regulation 834/2007*, prescribe requirements for the production of products labelled as 'Organic'. The use of plant protection products in organic production is restricted to a limited closed list. Thifluzamide, being a recognized plant protection product, is not a permitted product and therefore the description 'Organic' was considered false.

Aflatoxin in dried figs

The case arose as the result of a dispute around the level of aflatoxins in a sample of dried figs.

The two-part sample was received as a pre-prepared slurry and analysed in accordance with Annex II of retained Commission Regulation 401/2006 along with appropriate blanks and spiked samples. Three replicate analyses were carried out on three consecutive days. Spike recoveries were acceptable, and the results corrected accordingly (Table 2).

For sample 1358606, the presence of aflatoxins was confirmed by LC-MS/MS.

Retained Commission Regulation 1881/2006 setting maximum levels for certain contaminants in foodstuffs, prescribes maximum concentrations of 6 µg kg^{-1} and 10 µg kg^{-1} for aflatoxin B1 and total aflatoxin respectively. Allowing for measurement uncertainty, the amount of total aflatoxin was above the maximum permitted amount in sample 1358606, and therefore the sample was deemed unsatisfactory.

Table 2

LGC Sample Reference	Mean Concentration Aflatoxin B1 (µg kg^{-1})	U (µg kg^{-1})	Mean Concentration Total Aflatoxins (µg kg^{-1})	U (µg kg^{-1})
1358606	5.53	0.31	20.25	2.82
1358607	<0.75		0.93	1.21

where 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. The total aflatoxin content is calculated as the sum of the individual aflatoxins B_1, B_2, G_1 and G_2.

Liposomal Vitamin C

This case was referred to the Government Chemist by the Advertising Standards Authority (ASA) and concerned the assessment of scientific data submitted in a dispute around the structure of a liposomal vitamin C product.

Evidence was provided by the complainant and the food business operator in the form of scientific reports based on the use of transmission electron microscopy (TEM), dynamic light scattering (DLS) and particle tracking analysis (PTA) to reject and support, respectively, the claim that the product was in a liposomal form. The data assessment concluded that:

- sufficient care was not exercised when preparing the sample for analysis, potentially leading to false or misleading results;
- insufficient quality control was employed by the laboratories conducting the analysis;
- the absence of bilayer morphology in the TEM could have resulted from poor or incorrect technique during the sample preparation stage;
- DLS can provide information on particle size, but not on their nature and, likewise, PTA can only provide evidence on particle size and not structure;
- some of the conclusions drawn from the data presented were considered tenuous in the absence of appropriate control experiments.

In conclusion, the data presented by both parties was considered weak, with that provided by the complainant not proving the absence of liposomes and that by the food business operator not proving their presence.

4

The 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 bio-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 our expert opinion is sought on topical issues such as cannabidiol (CBD), allergens or food authenticity claims. We answered over 54 requests for advice during 2021.

Figure 2 shows the origin of the source of the enquiries. Figure 3 shows the breadth of enquiries across many topics – CBD, allergens, authenticity and measurement issues being amongst the most common. The 'other' category included enquiries on trace elements, sampling and analytical techniques.

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.

Expert opinion to stakeholders

Government Chemist staff provide their expert input into a number of Committees (detailed in the "membership" section of www.gov.uk/governmentchemist website) to influence the development of new legislation, standards and policy and to ensure that they are based on sound measurement science and are fit-for-purpose.

In addition, the Secretary of the Food Authenticity Network (FAN), Dr Mark Woolfe, chaired the UK mirror Technical Committee (BSI AW/34/46) for CEN TC460 (Food authenticity) and its Working Groups, and the Chair of FAN's Advisory Board, joined BSI committee AW/90 Quality systems for the food industry which manages the UK input into ISO 22000 (Food safety management system).

Response to consultations

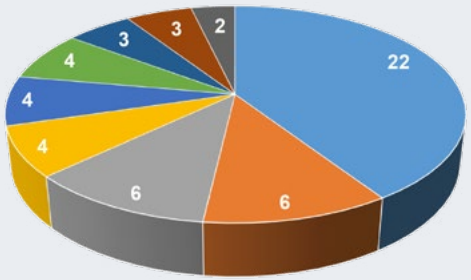
Consultations are carried out by the government (including the devolved administrations and agencies), standards bodies or Directorates-General of the European Union, to obtain the input of both interested and expert stakeholders on proposed new policy, guidance or legislation, prior to enactment. They 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 NML and wider LGC organisation across a range of analytical science, to respond authoritatively and independently where the consultations have chemical or bioanalytical measurement implications.

The consultations responded to by us during the year are listed below.

- **Consultation on Food Standards Agency Principles for Assessing Uncommissioned Evidence (FSA April 2021)**
- **Reforming the Framework for Better Regulation – A consultation (BEIS October 2021)**

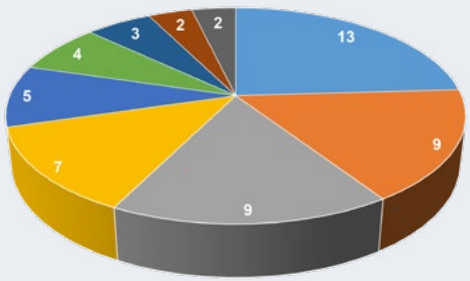
Source of enquiries



- Commercial / Consultant
- Local authorities
- Industry and trade associations
- Academia
- Government Department, overseas
- Official Control Laboratory
- UK Government departments
- Journalist / press / radio / TV / journals
- Independent

Figure 2 Distribution of enquiries by source

Enquiry topics



- Cannabidiol
- Food components/analysis
- Allergens
- Referee analysis
- Regulation
- Food authenticity and safety
- Other
- Manuscript review, articles, interviews, etc
- GMO

Figure 3 Distribution of enquiries by topic

5

Impact of our work

The impact of the work of the Government Chemist programme is broad and the effects can be observed in a number of ways.

Horizon scanning activities identify the areas where referee cases are more likely to arise or where new legislation may lead to food business operators and local authorities requiring advice or support. We can then prioritise the resources required to plan and carry out our research projects to support the areas identified.

These projects have benefits beyond the Government Chemist's statutory function. They often impact on the wider measurement community by promoting best measurement practice in the scientific areas where disputes are more likely to arise.

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.

Building new capabilities

Guidance for characterization of in-house reference materials for light element stable isotope analysis

Measurements of the natural variations in isotope ratios of the "light" elements (hydrogen, nitrogen, carbon, oxygen and sulphur) have many applications within forensic sciences. These include source inference (e.g. geographic origin of drug seizures, distinguishing genuine and counterfeit medicines), detection of food adulteration and authenticity (e.g. the addition of high-fructose corn syrup to honey or verification of the geographical origin of protected-origin foods) and distinguishing materials that are otherwise chemically and physically identical (e.g. linking tapes or other packaging materials found at a crime scene to similar materials available to a suspect).

Isotope ratios of the "light" elements are often reported as isotope delta values. Isotope delta is simply an expression relating the ratio between two isotopes of an element within a sample to the same isotope ratio in a measurement standard. To compare isotope delta values between different materials it is therefore necessary that both isotope delta values are relative to the same measurement standard – in this way both isotope delta values share the same traceability. The instruments used to measure isotope delta values of the light elements are typically isotope ratio mass spectrometers, but optical spectroscopy methods can also be employed. These instruments require calibration using reference materials of known isotope delta value. The availability of reference materials is therefore a fundamental need for traceable isotope delta measurements. They are also vital for quality control and assurance purposes.

There can be significant matrix effects when measuring isotope delta values and there are comparatively few matrix reference materials available. Furthermore, some reference materials are critical for maintaining the isotope delta scales as they define specific points and therefore daily use of these materials for calibration of instruments is discouraged. It has therefore long been the case that laboratories have been encouraged to characterise their own, matrix-matched reference materials for specific applications. Unfortunately, while this recommendation is well-established, there was almost no guidance available regarding how laboratories should characterise such in-house reference materials.

To address this need, experts in isotope ratio analysis and members of the NML Reference Materials Production Team distilled their knowledge of production of certified reference materials under accreditation to ISO 17034:2016 and ISO/IEC 17025:2017 to provide guidance for production of in-house reference materials for stable isotope analysis. This involved considering situations where relatively low numbers of units (i.e. ≤20) and small total amounts of material were produced, as well as adapting stability testing to provide a fitness-for-purpose result. The guidance covers five areas: (i) planning; (ii) material considerations including preparation, packaging, and storage; (iii) measurements and assessments; (iv) value and uncertainty assignment; and (v) monitoring and use. The guidance document has been published with open access to ensure that all interested parties have access to it[8].

[8] Philip J H Dunn, Dmitry Malinovsky, Gill Holcombe, Simon Cowen, Heidi Goenaga-Infante, Guidance for characterization of in-house reference materials for light element stable isotope analysis, https://pubmed.ncbi.nlm.nih.gov/34382250/2

Food authenticity testing using Next-Generation Sequencing (NGS) applications

NGS represents a transformative technology with broad applicability to food authenticity testing. It refers to a wide range of sequencing technologies that includes massively parallel and single molecule sequencing approaches. NGS is increasingly being applied to food speciation using techniques including metabarcoding (the use of an informative panel of markers to provide species/ingredient identification) and metagenome sequencing which characterises genomic populations. The increasing importance of NGS within this area has been highlighted by the recent Defra Authenticity Methodology Working Group – Technical Sub-Group (AMWG-TSG) guidance note, focusing on the use of NGS for food authenticity testing (published in 2021 – link on Government Chemist website: https://www.gov.uk/government/news/guidance-note-on-ngs-applications-for-food-authenticity-testing).

Benefits and challenges of NGS

In common with all analytical approaches, NGS-based techniques for food authenticity testing possess a range of benefits and challenges which impact upon the suitability and applicability of this approach. A selection of these factors, with potential support mechanisms, are detailed below.

Key benefits

- High discriminatory power of NGS sequencing due to the combination of high-quality sequence data with modern bioinformatics tools and sequence databases.
- Well-suited to screening applications, either through whole genome sequencing (WGS) methods which do not require prior knowledge of the sample composition (non-targeted approaches), or metabarcoding methods which typically target universal genetic markers.
- Capability to analyse complex samples containing multiple species unlike standard Sanger sequencing.
- Qualitative method with the potential for semi-quantitative analysis (further quantitative capability development likely with PCR-less NGS approaches).

Key challenges/considerations and support mechanisms

- **Analyte requirements:** In common with molecular biology-based approaches, NGS is restricted to the analysis of biological materials that contain extractable nucleic acid.
- **Costs**: The high costs associated with early generation instruments, although these are being reduced through the development of lower cost instrument platforms.
- **Computing/bioinformatics/ storage resources:** NGS approaches are dependent on adequate computational and data storage resources to process large and complex NGS runs. Cloud-based computing platforms offer an alternative to local data processing/storage.
- **Lack of harmonisation and standardisation:** NGS is an emerging technology which suffers from a general lack of harmonisation/ standardisation within the foods area. Support mechanisms include the development of suitable method validation frameworks, guidance, reference materials and Proficiency Testing (PT) schemes to support the UK testing community.
- **Data issues:** NGS (in common with Sanger sequencing) is dependent on the availability of high-quality sequence databases.
- **Training requirements:** The minimum skill level required for NGS analyses are typically higher than Sanger sequencing.

Application of NGS to food authenticity testing

Adulteration/substitution of meat samples has been highlighted by the FSA and Defra as one of the more common forms of food fraud and is well-suited to the application of NGS. In the 2020-2023 Government Chemist programme, a project was developed to further enhance NGS capabilities by exploring the use of a cutting edge and low-cost single molecule NGS sequencing platform, the MinION™ system (Oxford Nanopore Technologies). This technology represents a portable, commercial, real-time sequencing platform for high-throughput DNA and RNA sequencing. The platform technology is based on the minute changes in current when a nucleic acid molecule transitions through a nanopore.

A small-scale study based on a meat adulteration model (pork meat in beef meat) was devised using a WGS approach to capture analytical performance. The analytical workflow (Figure 4) utilised simple/rapid library preparation processes (~10 mins) and streamlined bioinformatics pipelines to identify pork adulteration down to at least the 1% w/w level. Future work will aim to improve the sensitivity, optimise bioinformatics pipelines and develop quantitative capabilities to improve analytical throughput/performance.

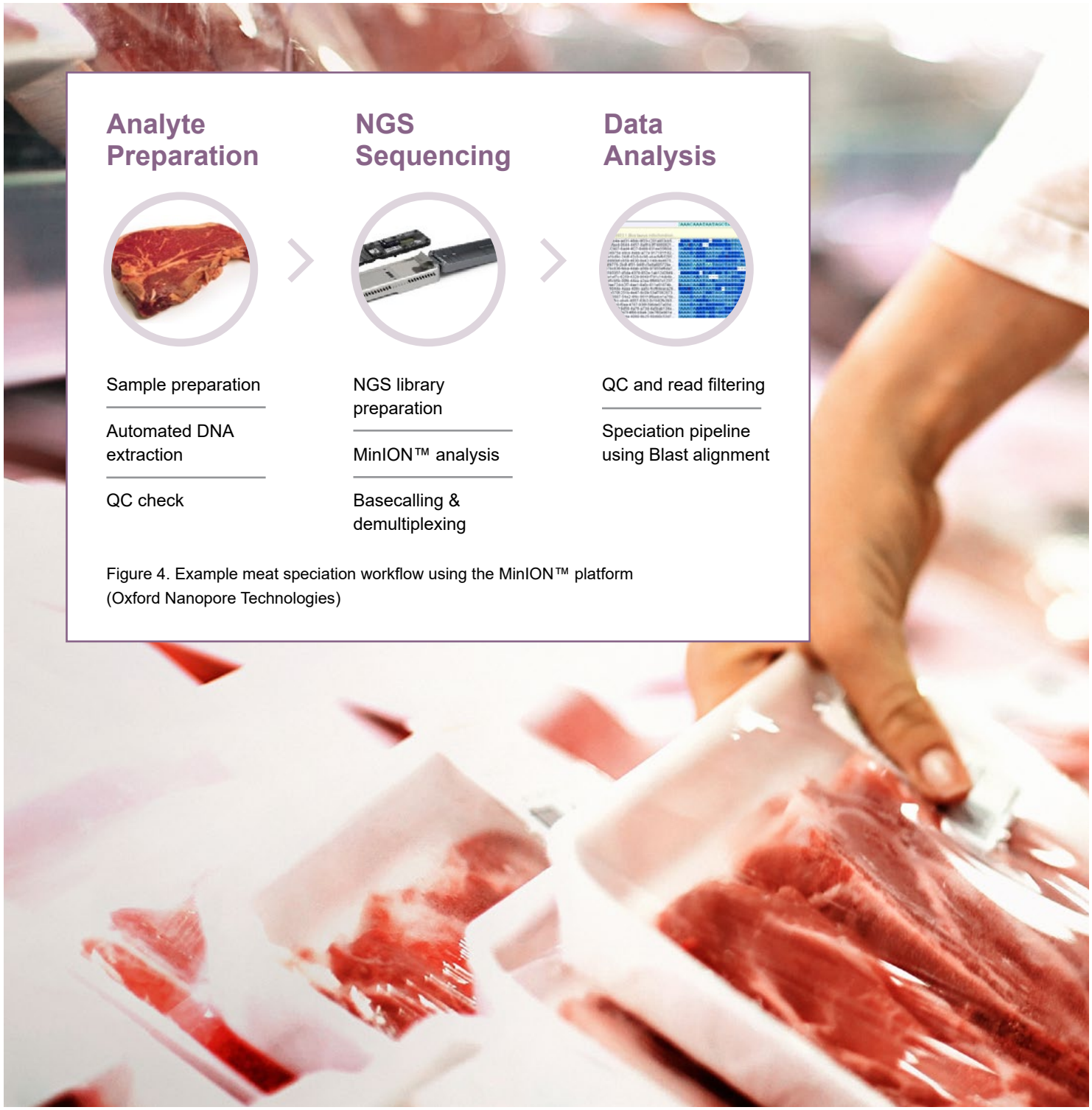


Figure 4. Example meat speciation workflow using the MinION™ platform (Oxford Nanopore Technologies)

Species identification and quantitation: Government Chemist input into the SEATRACES project

SEATRACES is an InterReg Atlantic Area Project (European Regional Development Fund) aimed at demonstrating to stakeholders (producers, industry, markets and consumers) that traceability and labelling are critical components needed to help protect and monitor Atlantic Area's fisheries and aquaculture.

An opportunity arose for the Government Chemist Team to contribute to an international collaborative trial of a new method based on DNA sequencing for the identification of commercially important crustacean species (e.g. crab, prawn, shrimp, lobster, and crawfish species).

Following on from our previous successful participation in a similar Labelfish project to identify important marine fish species, our further involvement in the identification of important crustacean species using a related molecular biology method was considered beneficial.

The method subject to this collaborative trial used Sanger sequencing of the important standardised DNA barcodes of Cytochrome c oxidase I (COI) and 16S rRNA gene segments to identify important crustacean species. Twelve laboratories from five European countries were involved in the trial, including the Government Chemist representing the UK. A standard operating procedure for the method was provided, along with nine samples of crustacean materials, representing species of commercial relevance and the diversity of the taxonomic group.

Following successful extraction of the DNA from the samples supplied, PCR was performed for the two barcode markers, relevant consensus sequences constructed and these were then challenged against reference sequences in the publicly available GenBank and BOLD DNA databases, in order to make positive candidate species identification.

Results from the trial indicated that a number of analytical challenges were encountered by some of the laboratories, including not being able to obtain sequencing amplicons, issues with generating consensus sequence information, only being able to identify the organism at the genus level or mis-classification of the species identity.

As part of this international ring-trial, the Government Chemist function was completely successful in providing identification down to the species level for all nine of the test samples provided. Whilst a number of other participating laboratories were only successful at the genus level of identification, the project has provided demonstrable evidence of Government Chemist staff expertise and competency in this area.

The project highlighted the clear utility of DNA sequencing methods to afford positive identification of commercially important crustaceans at the species level. Key points from the study included the importance of carefully using DNA sequences when aligning these with public databases for sample identification. The results also highlighted the need to maintain expertise in order to make an informed decision on species identity when using such databases. To promote the likelihood of making a correct species identification, it is recommended that both barcoding markers of 16S and COI are used, as they complemented each other well and provided more robust and reliable identification of a broad range of commercially relevant crustacean species.

CBD and controlled cannabinoids

Building on capability established in 2020, the Government Chemist continued work on cannabidiol (CBD) and controlled cannabinoids in 2021.

To assist regulation and trade, the Government Chemist published a tutorial review of the common names, abbreviations, regulation, psychoactivity and analytical methodology for the principal cannabinoids. Their chemical structures and IUPAC nomenclature were also included. The open access paper is available at the Journal of the Association of Public Analysts (JAPA)[9].

An international interlaboratory comparison on CBD and controlled cannabinoids, jointly funded by OPSS within the Department for BEIS, the FSA, and the Home Office, and carried out in collaboration with FSS and the Defence Science and Technology Laboratory (DSTL), involving 35 laboratories, was completed. The results showed good agreement between most laboratories (82%), demonstrating their capability to determine CBD in consumer products successfully. In addition, laboratories demonstrated the ability to detect controlled cannabinoids in the consumer products.

When the ministerial commission asked the Advisory Council on the Misuse of Drugs (ACMD) to specify which controlled cannabinoids should be controlled and to set an unavoidable trace level for each of these within consumer CBD products, the Government Chemist was able to feed in the findings of the interlaboratory comparison to the ACMD's consumer CBD products: call for evidence[10]. ACMD has now published[11] its advice on consumer CBD products making several recommendations. The Government Chemist's work on CBD was cited in the letter[12] from the ACMD Chair to Kit Malthouse MP, Minister of State for Crime, Policing and Justice for "providing the main evidence for the practical capacity for the analytics industry to test" for such products. The Government Chemist will continue to work with UK regulators and other stakeholders to help take the ACMD's recommendations forward.

The Government Chemist has continued to be represented on the United Kingdom Accreditation Service (UKAS) CBD Food Product Approval Awareness Expert Group and also convened a group at the request of the FSA, with UKAS and Fera, to discuss the need for a best practice measurement guide for CBD. This group has meet three times and in the latest meeting, it was agreed that further work on controlled cannabinoids is needed.

Two e-seminars on CBD are also to be produced for publication on the Government Chemist website early in FY23.

- Cannabidiol (CBD) in Food Supplements: to help manufacturers, suppliers and laboratories understand the issues surrounding the use of CBD in food supplements.

- Testing Cannabidiol (CBD)-containing foods: to disseminate guidance and best practice on testing CBD-containing foods – the legislative background, and scope and limitations of the analytical approaches employed will be included.

[9] http://www.apajournal.org.uk/html/japa_vol_49_pg__01-28.html

[10] https://www.gov.uk/government/news/commercial-cannabidiol-cbd-products-call-for-evidence

[11] https://www.gov.uk/government/publications/acmd-advice-on-consumer-cannabidiol-cbd-products

[12] https://www.gov.uk/government/publications/acmd-advice-on-consumer-cannabidiol-cbd-products/cover-letter-from-acmd-on-consumer-cbd-products-report-accessible-version

Sharing and transferring knowledge

The Government Chemist supports innovation and policymaking by sharing knowledge gained through our work, particularly in referee analysis, with the analytical and regulatory communities to improve knowledge and skills.

Government Chemist conference

The Government Chemist 2021 Conference “Safe food for tomorrow’s world” took place online on 23 and 24 June. The conference included talks from 20 national and international speakers on topics from regulatory perspective, how food science can impact health outcomes and novel solutions for food authenticity and sustainability. The talks were well received by the 240+ participants who attended the conference for at least one talk.

This event had originally been planned for June 2020, then postponed to June 2021 and finally delivered as an online event. The transition to the online platform did present technical challenges and limited the interaction between participants. However, it also presented an opportunity to engage a greater number of stakeholders at UK and international level.

A great proportion of participants were from UK government departments and local authorities, with representation from academia, trade associations, industry and private consultants. However, some participants joined the conference from Turkey, Slovakia, Latvia, Uruguay and Hong Kong.

The Government Chemist website

The Government Chemist website is hosted on the GOV.UK platform with the landing page: www.gov.uk/governmentchemist

The Government Chemist pages can also be reached from anywhere on the site by entering “Government Chemist” in the search box. Updates on Government Chemist news can be obtained by subscribing for alerts via the website.

During 2021, 23 articles (including news and reports) were published on the Government Chemist webpages.

The Government Chemist team also uses Twitter (@NML_ChemBioGC) and LinkedIn (https://www.linkedin.com/showcase/uk-nml/) for wider dissemination of articles, events and news.

Training

The Government Chemist acquires a great deal of expertise and knowledge through the discharge of its statutory function. This forms the basis of material which is used in the provision of training for practising analysts.

During 2021, face-to-face training events had to be transitioned to enable delivery online. In addition to the Conference organised in June, a November webinar on the subject of agricultural sustainability was organised. Presented by Darshna Vyas, it covered the impact of COVID-19 on agricultural sustainability and explored how genomics can play its part in building resilience for the future.

Links to the recorded webinar are available from the www.gov.uk/governmentchemist pages.

Joint Knowledge Transfer Framework

This jointly funded cross-government (Defra/ FSA/FSS/Government Chemist) programme for knowledge transfer is aimed at:

- creating better value for money by maximising resource use and delivering a more sustainable and efficient approach to knowledge transfer;
- building analytical laboratory capability to respond to future food safety and fraud incidents;
- continuing to support delivery of the response to the 2014 Elliot review into the integrity and assurance of food supply networks following the 2013 horse meat incident.

A report highlighting the framework's activities during its first three years of operation (2017-2020), including delivery of two workshops, nine e-seminars and a set of work instructions, is now available[13].

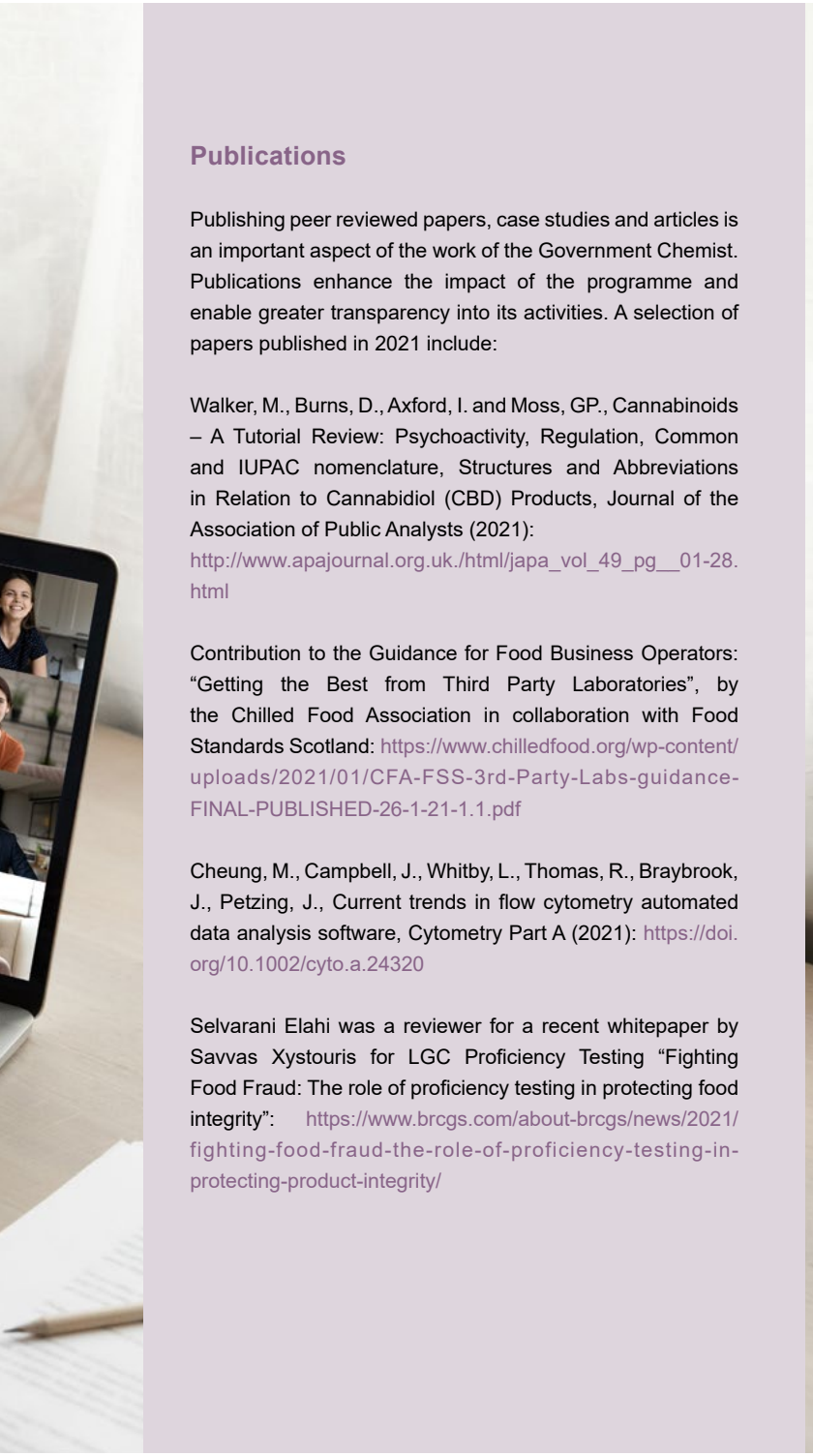
During 2021 two webinars were organised:

"Webinar on fish speciation for food authenticity", presented by Dr Tim Wilkes, LGC followed by a Q&A panel including Malcolm Burns, LGC and Ivan Bartolo, Sea Fish Industry Authority

"Webinar on Allergen Risk Assessment", presented by Ms Liz Walton, Senior Policy Advisor, Food Hypersensitivity, FSA and Dr Benjamin C. Remington, Food Allergy Consultant, University of Nebraska-Lincoln. The webinar was followed by a Q&A panel including Dr Hazel Gowland, Allergy Action UK and Dr Michael Walker, IGFS, Queen's University, Belfast

Links to the recorded webinars are available from the **www.gov.uk/governmentchemist** pages.

[13] https://www.foodauthenticity.global/blog/joint-knowledge-transfer-framework-for-food-standards-and-food-sa



Publications

Publishing peer reviewed papers, case studies and articles is an important aspect of the work of the Government Chemist. Publications enhance the impact of the programme and enable greater transparency into its activities. A selection of papers published in 2021 include:

Walker, M., Burns, D., Axford, I. and Moss, GP., Cannabinoids – A Tutorial Review: Psychoactivity, Regulation, Common and IUPAC nomenclature, Structures and Abbreviations in Relation to Cannabidiol (CBD) Products, Journal of the Association of Public Analysts (2021): http://www.apajournal.org.uk./html/japa_vol_49_pg__01-28.html

Contribution to the Guidance for Food Business Operators: "Getting the Best from Third Party Laboratories", by the Chilled Food Association in collaboration with Food Standards Scotland: https://www.chilledfood.org/wp-content/uploads/2021/01/CFA-FSS-3rd-Party-Labs-guidance-FINAL-PUBLISHED-26-1-21-1.1.pdf

Cheung, M., Campbell, J., Whitby, L., Thomas, R., Braybrook, J., Petzing, J., Current trends in flow cytometry automated data analysis software, Cytometry Part A (2021): https://doi.org/10.1002/cyto.a.24320

Selvarani Elahi was a reviewer for a recent whitepaper by Savvas Xystouris for LGC Proficiency Testing "Fighting Food Fraud: The role of proficiency testing in protecting food integrity": https://www.brcgs.com/about-brcgs/news/2021/fighting-food-fraud-the-role-of-proficiency-testing-in-protecting-product-integrity/

Engagement with stakeholders

In addition to the regular participation in the advisory committees described in the Advisory Function section of this Review, the Government Chemist is invited to contribute to a number of events organised by stakeholder organisations. Some of the highlights of the year are outlined below.

- Selvarani Elahi joined Riccardo Siligato of the European Commission's Joint Research Centre and Bruno Sechet of Integralim, for a discussion on the prevention of food fraud in a webinar entitled "How to tackle food fraud". The event had over 500 people from 50 countries.
- Selvarani Elahi was invited to give a presentation on the role of the Government Chemist at the Defra's Innovation, Productivity and Science team meeting.
- The Government Chemist sent a letter to Prof. Owen Bowden-Jones, Chair of the Home Office ACMD detailing the Government Chemist Team's work in the CBD area. This was in response to a letter Prof Bowden-Jones had received from the Minister for Minister of State for Crime and Policing asking for advice on consumer CBD products.
- Malcolm Burns provided advice at eight EU working group meetings in March, including those aimed at providing best measurement practice advice for minimum performance requirements for GMO analysis using digital PCR, and detection of GM animals and products of gene editing.
- Malcolm Burns attended the PlantEd Cooperation in Science and Technology (COST) Action series of April seminars entitled "From research to innovation with new breeding techniques". This set of webinars focussed on the use of new gene editing technologies for improvement of a number of important crop species. Presentations were provided by speakers representing agri-biotech companies, control authorities and the European Commission.
- Selvarani Elahi met with the Head of the Scottish Food Crime and Incidents Unit to discuss the potential for the Global Alliance on Food to collaborate with the FAN.
- Julian Braybrook hosted the Chief Scientific Adviser (CSA) from BEIS, Paul Monks and the deputy CSA, Soheila Amin-Hanjani, the CSA from Defra, Gideon Henderson and the CSA from FSA, Robin May in a series of visits to the LGC and NML facilities. Discussions covered partnership activities, potential areas of joint activity across FSA/Defra and BEIS on net zero challenges beyond purely transport, and forthcoming formulation activities ahead of the next Government Chemist programme (2023-25).

Areas of collaboration with stakeholders

It is clear that collaboration with other organisations with common or complementary interests not only helps the Government Chemist discharge its role efficiently, but also contributes to a more rapid development and implementation of methods and standards.

For example, Selvarani Elahi undertook a 6-month part time secondment with Defra's Food Science Team working on a horizon scanning initiative and honey authenticity. She also produced a policy paper on alternative proteins as part of future net zero considerations.

Other substantial collaborations are outlined below.

Honey Authenticity

The Government Chemist started working substantively on honey authenticity with organisation of the 2019 UK Honey Seminar[14]. This brought stakeholders together for the first time to discuss determination of exogenous sugars by NMR and, ideally, come to an agreed position. There was consensus support among attendees for NMR as a tool in verifying the authenticity of foods, but based on available evidence, NMR methods were considered unsuitable for detecting exogenous sugars in honey for enforcement purposes. The main reason provided was the lack of information on the databases underpinning interpretation of NMR outputs; more specifically, the lack of origin of 'authentic' samples, sample representation of the UK honey market and published independent external validation and scrutiny of the databases were reported as being particularly problematic.

Since then, the Government Chemist has continued to work with Defra, FSA, and FSS to facilitate progress on some of the underpinning scientific issues related to honey authenticity; projects that the Government Chemist has been involved in are detailed below.

- Three e-seminars relevant to honey authenticity produced under the Joint Knowledge Transfer Framework for food standards and safety.
  - ► A webinar on the 'Global Honey Supply Chain' was held with keynote presentations from Defra & the **UK Honey Association**, with 550 people joining the live event. A recording of the webinar is available on the **Government Chemist website**. The presentation from the Honey Association on the global honey supply chain is being produced as an e-seminar that will have been published by the time this Review is available.
  - ► Two further knowledge transfer e-seminars, which will assist in disseminating information on honey authenticity testing and best practice in establishing authenticity databases, are in development:
    - » Using NMR testing for the determination of exogenous sugars in honey
    - » Establishing and curating databases for food authenticity.
- Following recent allegations in the media that honey sold in the UK may be adulterated with added sugars, the Government Chemist was requested by the FSA to undertake an independent review of the certificates underpinning these media stories; the Government Chemist view was published recently in the form of two peer reviewed papers[15,16]. The second paper recommends a forensics-based evaluative reporting process to support authenticity analysis.
- Work on developing guidance on how a weight of evidence approach for food authenticity should be applied in practice has commenced. The guidance is targeted at analysts and enforcement officers and aims to harmonise approaches to support any follow-up action required. Paul Hancock is chairing this working group, with Defra providing the Secretariat.
- Work has commenced with the United Kingdom Accreditation Service (**UKAS**) to explore the overarching principles in standardising the assessment and accreditation of non-targeted authenticity methods such as NMR. Selvarani Elahi has been attending meetings with UKAS, Defra and FSA, at the invitation of Defra and FSA.
- The FSA Data Trust Project[17] seeks to create a trust framework for honey authenticity. Selvarani Elahi has been attending and inputting into project update meetings at FSA's request.

The Government Chemist will lead further work with stakeholders in 2022/23 to produce a protocol for the collection of authentic samples and to establish a framework for the scrutiny of authenticity databases.

[14] https://www.gov.uk/government/news/honey-authenticity-seminar-2019-report

[15] Honey authenticity: the opacity of analytical reports – part 1 defining the problem, https://doi.org/10.1038/s41538-022-00126-6

[16] Honey authenticity: the opacity of analytical reports – part 2, forensic evaluative reporting as a potential solution, https://doi.org/10.1038/s41538-022-00127-5

[17] https://www.food.gov.uk/research/research-projects/food-data-trust-a-framework-for-information-sharing

Food Authenticity Network

The Food Authenticity Network (FAN) (www.foodauthenticity.global) operates as a public-private partnership model.

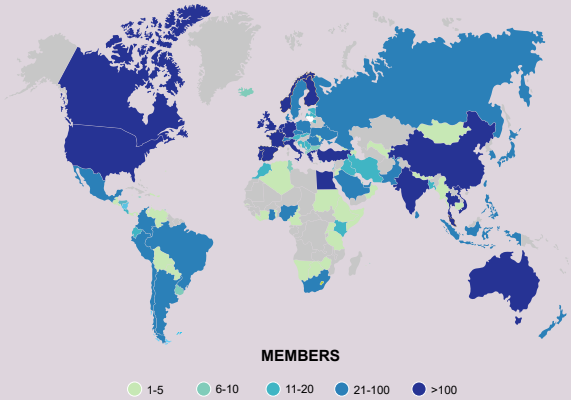
FAN continues to share best practice on food authenticity testing and food fraud mitigation measures around the world, helping to better protect food supply chains and provide greater consumer trust in the food they buy.

FAN has continued to achieve good growth during 2021, with members and users of the open access website, at 31 December 2021, shown in Figure 5.

Figure 5: Number of members and unique users

2,896
members
from 90 countries (37% increase from 2020)

34,491
unique users
from 165 countries accessed the website (60% increase from 2020).



Notable publications for the year included:

- annual summary of FAN activity following ratification by the FAN Advisory Board;
- two FAN Newsletters: January and October;
- a review of global food fraud definitions conducted by FAN was shared with two international groups currently developing definitions for food fraud and related terms.

Two new Food Authenticity Centres of Expertise (CoEs) have been added to the FAN website:

- Public Analyst Scientific Services Limited (General Proficiency);
- Bangor University (Specific Commodity: Cereal grains).

This means stakeholders now have direct access to named experts in 15 Food Authenticity Centres via the Centre of Expertise section of the FAN website.

In addition:

- an article on FAN was featured in the UK Food Security Report, which examines past, current and predicted trends relevant to food security, to present the best available and impartial analysis of food security in the UK, and to lay the groundwork for future Food Security Reports;
- an article on FAN was featured in the National Food Crime Unit's (NFCU) first Food crime newsletter[18];
- Citing FAN as a resource, Safefood, published a guide for food manufacturing businesses to help protect their businesses from food fraud.

iKANN

The Government Chemist collaboration with NNEdPro, the International Knowledge Application Network Hub in Nutrition (iKANN) (www.ikann.global), continued with the publication of evidence collections on COVID and nutrition and Cardiometabolic risk and nutrition. Future evidence collection will be on 'Food Security and nutrition'.

A Twitter account for iKANN (twitter.com/ikann_global) was launched in April 2021 and, from October, monthly summaries are being produced and sent to all members of iKANN (211 from 31 countries at 31 December 2021).

After successful implementation of NNEdPro's Mobile Teaching Kitchen (MTK) model in India and Mexico, the model won a Cambridge University Public Engagement award and discussions are in progress with a UK regulator to adapt the model for a UK setting.

[18] https://documents.foodauthenticity.global/index.php/newsletters/food-crime-newsletter-quarter-1-2021/

LGC, Queens Road, Teddington, Middlesex TW11 0LY, UK
Tel: +44 (0)20 8943 7000
www.lgcgroup.com • Science for a safer world
www.gov.uk/governmentchemist

Department for Business, Energy & Industrial Strategy

FUNDED BY BEIS