



Department for
Business, Energy
& Industrial Strategy

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Government Chemist

Review 2018

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...our responsibilities include assuring sound measurement science is applied to assessing the quality, composition, labelling and chemical contamination of food...

Foreword from the Government Chemist



As I contemplate my introduction, for this my first Government Chemist Review, I am struck by the dichotomy between the uncertainty facing the environment in which the role operates and the principal objective of this review, to report the referee function as defined in the various related statutes of law. It is impossible to estimate the likely effects of EU exit in the short term and the potential expansion of international trade agreements, as we supplement the UK's reliance on trade with our European partners. However, it would only be reasonable to expect a need to support an increase in disputed measurements and the associated demand for casework interpretation.

The proposal, endorsed by the Food Standards Agency Board, for a formal review of the UK official control laboratory system in its entirety includes the role of the Laboratory of the Government Chemist as the UK referee laboratory. I look forward to working with colleagues in government to support the findings of the review. I welcome the continued evolution of food and feed regulation as clearly set out in FSA's "Regulating Our Future" programme, in particular as it addresses the identified shortcomings in food standards regulation. Food standards encompasses much of my

own responsibilities assuring sound measurement science is applied to assessing the quality, composition, labelling and chemical contamination of food.

Being new to the role also allows me to review the science we currently employ to address the continued increase in the complexity of the measurements undertaken. However, it is not simply about the quality of our science. An enhanced and wider utility of our capabilities suggests a much broader engagement with stakeholders to ensure the impact of our science benefits all interested parties.

There is, therefore, a clear need to plan for a future increase in the critical mass of our experienced team of scientists to ensure our continued high scientific standing. The establishment of the Office of the Government Chemist ensures internal mechanisms are in place to review the status of our science, particularly with the continued governance from the independent experts who comprise the Government Chemist Programme Expert Group.

My first months in post have already started to highlight the benefits achievable through a process of greater engagement. This annual

review demonstrates that our science remains at a level expected and appreciated by the stakeholders we serve. It reflects the diligence of my predecessor, my deputy, specialist advisers, Michael Walker as referee analyst, and the wider team, as well as the synergy with our experts in the National Measurement Laboratory (NML) at LGC.

I welcome the opportunity to work closely with our sponsoring government department (the Department for Business, Energy and Industrial Strategy, BEIS), members of our governance group, the other government departments and administrations across the UK, NGOs and industry. I am still very much in listening mode and welcome feedback on any aspect of the Government Chemist role so that it remains fit for the future, whatever that holds.

A handwritten signature in black ink, appearing to read "Julian Braybrook". The signature is stylized and written in a cursive-like font.

Dr Julian Braybrook
BSc, PhD, Hon DPhil, FRSC
Government Chemist

Note from the Chair of the Government Chemist Programme Expert Group

I am always pleased to be invited to look back at another year of work by the Government Chemist. During 2018 the function experienced some changes and was involved in wide ranging activities to extend and maximise the impact of the scientific work undertaken by the team.

I would like to acknowledge the strong and clear steer that the programme has had from Dr Derek Craston, who stood down in June after a ten-year tenure as Government Chemist. The members of the Government Chemist Programme Expert Group, and myself as the Chair, are extremely grateful for Derek's lead over that time, and his effort in ensuring an equally effective successor.

And so, we welcome Dr Julian Braybrook to the role and look forward to working with him and the rest of the Government Chemist team to continue serving the public with sound scientific measurement and advice. We are confident that under Julian's guidance, the programme will continue to go from strength to strength.

During 2018, the Government Chemist team undertook a wide range of referee cases, such as detection of mycotoxins in nuts, pesticides in

animal feed and formaldehyde in food contact materials. The scientific approach underpinning the resolution of these cases is detailed in section 3, "Dispute resolution".

The biennial Government Chemist conference took place in June 2018 in London. You can read about it in more detail in Section 5, "Impact of our work". On a personal note, it was a great opportunity to interact with stakeholders not only interested in the Government Chemist's work, but also in how to make the best use of the scientific knowledge and advice provided.

Whilst a review is inevitably a backwards look at the recent past, the Government Chemist is always keeping an eye on the future and preparing for forthcoming challenges. Preparing for exiting the EU still is, and will be, a focus for the team. This is reflected in the quarterly legislation update reports, published on the website, summarising changes in regulation affecting the manufacture and retail of food and feed. Further challenges looming on the near and far horizons that the team are preparing for include the "consumer as an analyst" and evolving consumer behaviours.

This review details the excellent scientific work undertaken to address measurement challenges and to support enforcement of UK food law. The Government Chemist and his team endeavour to make opportune use of expertise to continue to provide a valued service to the UK public. I hope you enjoy reading the review.



Professor Paul Berryman
*BSc, MChemA, PhD, MBA,
FRSC, CSci*
*Chair, Government Chemist
Programme Expert Group*



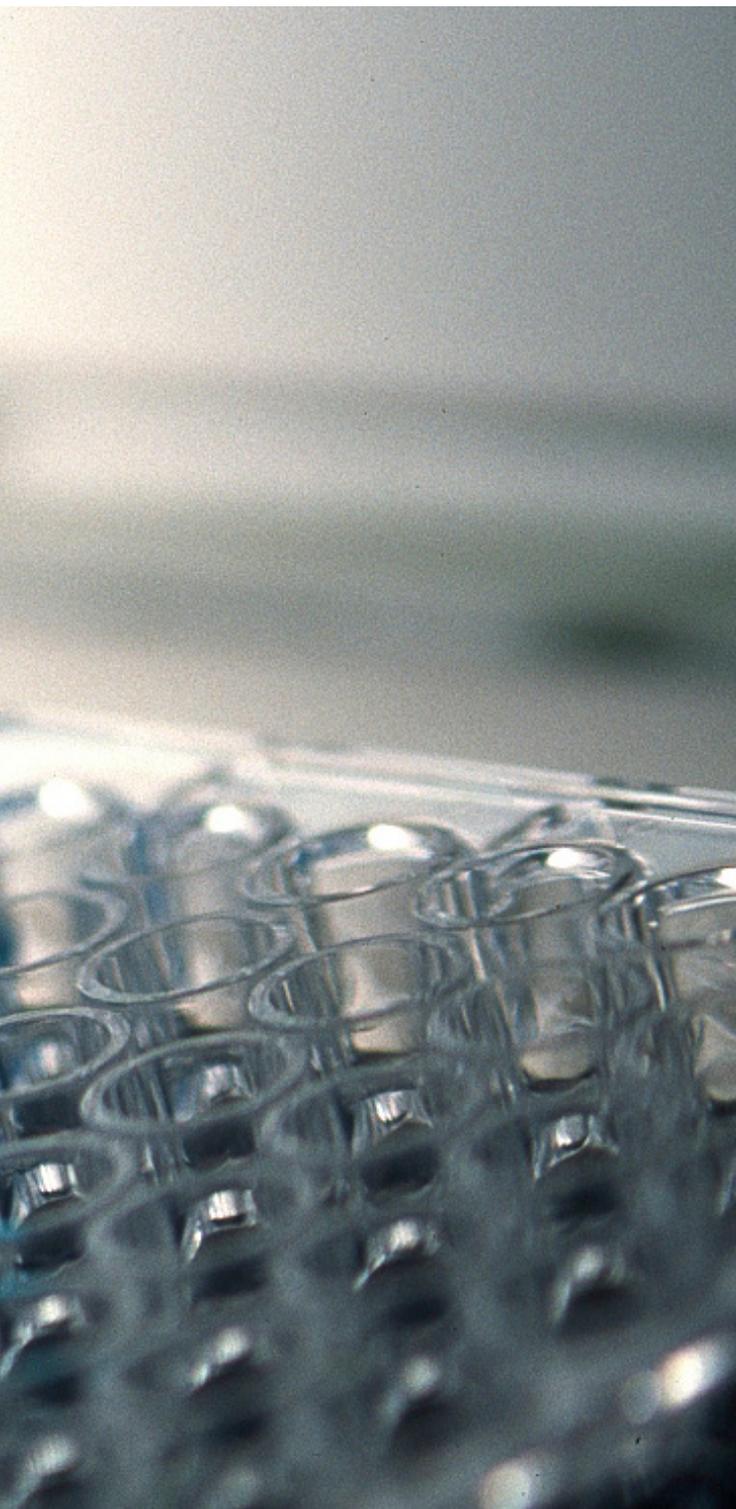
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What we do

The Government Chemist role was created to help protect the public from fraud, malpractice and harm. In 1875, the laboratory of the Government Chemist 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, which are funded by the Department for Business, Energy and Industrial Strategy (BEIS).

The Government Chemist uses up-to-date and authoritative measurement procedures coupled with experienced interpretative skills to act as a fair and independent arbiter to resolve disputes, provide public protection 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. These duties (see Box 1, page 7) 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. 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, LGC, as the UK National Measurement Laboratory and Designated Institute for chemical and bio-measurement.¹

- ▶ **Section 3 reviews this 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 significant or important analytical science content. Our full consultation responses are published on the Government Chemist website; Box 3, page 18 lists the consultations we responded to during 2018.

- ▶ **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 in these areas.

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

Our governance

The Government Chemist programme is funded by BEIS. Within that department, responsibility for the Government Chemist lies with the International Science and Innovation Directorate.

BEIS has put into place arrangements to ensure that the Government Chemist programme is delivered competently, and that scientific standards, impartiality, transparency and integrity are maintained. The Government Chemist Programme Expert Group (GCPEG) provides this independent scrutiny, overseeing the delivery, planning and quality 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 associations, a consumer interest group and academia, with a broad range of backgrounds, skills and interests.

¹ www.lgcgroup.com/uk-national-measurement-laboratory/

GCPEG membership for 2018

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 a visiting Professor at the University of Reading. Paul has an extensive career spanning more than 30 years in which he has worked at a senior level with most of the top 100 global food companies. An Expert Witness and former Public Analyst, he holds the MChemA, an MBA and a PhD in Science Strategy. He was also CEO and Research Director at Leatherhead Food Research Ltd.

Robbie Beattie

Robbie is appointed as 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. He has had a varied career spanning a range of businesses and organisations including Royal Ordnance Factory, Scottish & Newcastle Breweries, and Medicines Testing Laboratory.

Thomas Bell

Tom is the Science Team Manager at the consumer association Which?, providing scientific expertise across the organisation on topics such as product safety, data security and a range of consumer based issues. Tom began his post-doctoral career as an analytical chemist at 3M Health Care.

Simon Branch

Simon is Director of Research, Development and Scientific Affairs at Herbalife. His career includes senior roles at Goldenfry, RHM Technology and the McCormick corporation. Simon has sat on a number of committees including the Royal Society of Chemistry (RSC) LGC Advisory Committee and the RSC Science and Technology Board.

Andrew Damant

Andrew led the Surveillance, Methods and Laboratory Policy Team at the FSA, responsible for the Agency's surveillance strategy, policy on UK national reference laboratories (NRLs) and official control laboratories (OCLs). Andrew is an official UK delegate on numerous international committees and an advisor to various UK committees. Andrew retired from the FSA during 2018.

Lucy Foster

Lucy is Programme Manager for food chain research at Defra. Lucy was previously at the FSA, having started her career as a government scientist at the Ministry of Agriculture, Fisheries and Food. Lucy offers a wealth of experience in food safety from a science and a policy perspective,

including microbiological foodborne disease, food hygiene, food additives and food compositional and labelling standards.

Stephen Garrett

Steve is Food Authenticity Team Leader at Campden BRI, having joined from the Institute of Food Research where he worked as a research officer developing molecular biology and immunological methods to detect food pathogens and contaminants.

Jonathan Griffin

Jonathan is Public Analyst and Technical Manager for Kent Scientific Services, and President of the Association of Public Analysts (APA). Having begun his career as a graduate scientist at Kent County Council, carrying out classical and instrumental analysis of foods, agricultural samples, water and consumer goods, Jonathan now represents Public Analysts in discussions with central and local government bodies and chairs the Council of the Association.

Kasia Kazimierczak

Kasia leads a multidisciplinary team covering marine science and shellfish hygiene, authenticity, allergens, foodborne viruses and surveillance at Food Standards Scotland (FSS). Kasia joined FSS from her previous role as a scientific advisor at the FSA in Scotland after her academic research career. Kasia brings significant experience in food safety, having worked in foodborne disease, chemical safety and shellfish teams.

Chelvi Leonard

Chelvi leads Laboratory Policy at the FSA having started her career in the Food Science Laboratory at the Ministry of Agriculture Fisheries and Food, developing legislation on mycotoxins and other contaminants. Chelvi is the UK representative at CEN and Codex meetings on 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, having qualified as an Environmental Health Officer and been part of, and managed, teams dealing with imported food ever since.

Andrew Millman

Andrew is the nominated representative for the British Retail Consortium. Andrew chairs the Authenticity and Chemical Contaminants and Emerging Risks Work Groups and is currently employed by Asda Stores Ltd, working within the Compliance team. Andrew brings significant experience of a wide range of food related subjects with specific interests

in food safety and quality, microbiology, food labelling, authenticity and analytical techniques.

Helen Munday

Helen Munday re-joined the Food and Drink Federation (FDF) in 2016 as Chief Scientific Officer having previously worked for the trade association as Director of Food Safety and Science. Helen is accountable for sustainability, and food safety and science policy briefs at FDF, drawing on her expertise in R&D, scientific and regulatory affairs as well as product development and innovation across the agri-food chain. As a Registered Nutritionist, Helen also contributes to health and wellbeing policy.

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 Associate Dean for Research for the Faculty of Science, Engineering and Computing at the university. Declan brings his experience across an academic career that includes the University of Bath, the University of Brighton and inflammation research at Barts and The London School of Medicine and Dentistry.

David Pickering

David is the Trading Standards Manager for the Buckinghamshire and Surrey Trading Standards Service and has been part of, and managed, teams dealing with food, animal feed and animal health. He has been the Chartered Trading Standards Institute's 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. Sophie brings expertise gained during her scientific career in government at Defra and the FSA in the areas of food standards and labelling, and microbiological food safety.

Roger Wood OBE

Roger is an experienced food analysis specialist, recently retired from the FSA. After being appointed as Chief Chemist at a Public Analyst and Consulting Chemist practice, Roger moved to the Ministry of Agriculture, Fisheries and Food and completed his MChemA. Roger has represented the UK at numerous EU working groups on methods of analysis and sampling in the food and feed sectors over many years and has been Chair of a number of international food analysis working groups.

Box 1 The Government Chemist in legislation

The duties of the Government Chemist as referee analyst are defined in or under:

Food Safety Act 1990

Food Safety (Sampling and Qualifications) Regulations 2013

Food Safety (Sampling and Qualifications) (Scotland) Regulations 2013

Food (Northern Ireland) Order 1989

Food Safety (Northern Ireland) Order 1991

The Food Safety (Sampling and Qualifications) (Wales) Regulations 2013

Rheoliadau Diogelwch Bwyd (Samplu a Chymwysterau) (Cymru) 2013

Natural Mineral Water, Spring Water and Bottled Drinking Water Regulations 2007¹

Materials and Articles in Contact with Food Regulations 2012¹

Agriculture Act 1970

The Animal Feed (Hygiene, Sampling etc. and Enforcement) (England) Regulations 2015¹

Genetically Modified Animal Feed Regulations 2004*¹

Human Medicines Regulations 2012

Farm and Garden Chemicals Act 1967

The Government Chemist is named and has other scientific responsibilities under:

Merchant Shipping Act 1995

Hydrocarbon Oil Duties Act 1979

Poisons Act 1972

The status and territorial extent of the Government Chemist are understood with reference to:

Freedom of Information Act 2000

Scotland Act 1998 (Cross-Border Public Authorities) (Specification) Order 1999

Administrative Provisions Act (Northern Ireland) 1928

¹ Enacted as separate legislation in England, Northern Ireland, Scotland and Wales

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 Analysts², 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, may countersign certificates of analysis.

²All referee case work is overseen by Michael Walker, a nominated officer holding the statutory MChemA qualification



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Figure 1 Government Chemist organogram and contact points



2

Focus on future challenges: "the consumer as analyst"

The science described in this review is often leading edge and is built upon pioneering foundations laid decades ago. But what are we doing now to ensure our successors have an equivalent framework to help them solve problems as yet unknown?



Dr Michael Walker
MSc MChemA CChem FIFST FRSC



The key regulatory and scientific themes that emerged from our far-horizon scanning exercise in 2016³ were:

- Regulation must allow confidence for the consumer and the wider society
- The shift from "chemicals" to "biologicals" in the food and farming sector
- The "consumer as analyst" using handheld devices
- Precision agriculture developed further with artificial intelligence
- Rapid advancement of synthetic biology and potentially cloning.

These themes inform our current programme of work. In this first keynote article we consider non-laboratory based technologies for the future.

Point of Use analysis – "the consumer as analyst"

The "consumer as analyst"⁴ has arrived much sooner than predicted originally, with recently commercialised devices purporting to indicate the presence of allergens in food. The potential, as well as limitations and risks, of such devices have received comment⁵. More widely, the ability to analyse multiple food samples and analytes at the point of use (PoU) has implications for cost-effective, rapid, non-targeted surveillance across all the analyte/matrix combinations we currently see in referee work.

Contrary to event-specific chemistries exhibited in the allergen PoU technologies, future "consumer as analyst" devices will potentially mirror current Near Infrared (NIR) or Raman instruments in probing solid matter with electromagnetic radiation. Advances in optics, battery power and data handling are already being realised alongside remote access to profiles and calibration data stored in the "cloud". Thus the simplicity of operation, low cost and high capability mean that spectroscopy, spectrometry and databases will likely be key to future developments.

This has informed our work in multispectral imaging (MSI), ambient ionisation mass spectrometry (AIMS) and nuclear magnetic resonance (NMR) spectroscopy, coupled with our salience of current good practice in authenticity database construction, chemometrics and mathematical modelling.

MSI represents an innovative and non-invasive technique combining both imaging and spectral technologies, permitting fast and accurate determination of surface colour, texture and potential chemical composition of a food sample. It is rapid (20 seconds under optimal workflow), cost-effective (<5p per sample for consumables), and boasts true non-targeted multi-analyte capability.

AIMS similarly offers rapid sample analysis (typically sub 5 seconds) and, whilst destructive, the high sensitivity of the technique requires little sample for analysis. The speed, specificity and coupling of both quantitative and qualitative analysis in one package offers a rapid way to fingerprint a wide range of food samples cheaply and quickly.

NMR is a very information rich and comprehensive analytical technique that can provide quick and unique chemical fingerprints of a wide range of materials with minimum sample preparation. None, though, can as yet be deployed as truly PoU but they have that potential for the future.

In 10+ years the Government Chemist may well still be arbitrating on physically tangible retained samples, but we foresee the ever increasing need to adjudicate on pass/fail, normal/abnormal decisions made on large consignments, by minimally trained operatives or, even increasingly, robots, using PoU technology. Equally, collated multiple PoU outputs from consumers as analysts will challenge prior assertions of food as safe, ethically acceptable, authentic, local, nutritionally balanced or properly labelled. Then, real-time forensic examination of the decision making process, the validation of the technique, the adequacy of construction, curation, retrieval and application of the calibration and database profiles will be questions to be settled.

We are at the beginning of a workstream that will prepare our successors for such challenges. But we can't do it alone. The appointment of the new Government Chemist offers an opportunity going forwards to re-emphasise our openness to establish broader collaborative relationships that allow us to continue to align the best minds in our team with those in research in the UK and further afield. Our planned wider stakeholder engagement will be a key element of this, but feel free to approach us on how we may be able to best work together.

³ Government Chemist Review 2016, <https://www.gov.uk/government/publications/government-chemist-annual-review-2016>

⁴ GCPEG member Simon Branch introduced this concept during the 2016 horizon scanning exercise

⁵ Popping, B., Allred, L., Bourdichon, F., Brunner, K., Diaz-Amigo, C., Galan-Malo, P., Lacorn, M., North, J., Parisi, S., Rogers, A. and Sealy-Voyksner, J., 2018. Stakeholders' guidance document for consumer analytical devices with a focus on gluten and food allergens. *JAOAC Int.*, 101(1), 85-189

3

Dispute resolution

The Government Chemist underpins public and industry confidence in the food and feed official control system by guaranteeing fair scientific treatment for all. We maintain the credibility of this referee role by stringent governance of the function, and painstaking analytical rigour. Our objective is the application of best practice measurement science to safeguard consumers, regulators, the agrifood sector and the courts from unwitting errors in complex analysis and interpretation.

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 fulfills the requirements for 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 independently evaluated by professional 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 and 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 samples referred to the Government Chemist is therefore more than simply a repeat test, and the resource expended on each case is considerably more than would normally be available to an official control or trade laboratory.

This is necessary for a number of reasons:

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

Overview of referee cases in 2018

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 and transferring our knowledge through hands-on training and workshops contributes to avoiding similar disputes in the future.

The statutory conditions for referral usually begin with the contemplation or commencement of legal proceedings where the prosecution intends to offer analytical evidence. During 2018, seven cases were referred (see Table 1); six in connection with food and one concerning animal feed. Of these, five were a result of dispute. Most of the referrals were familiar to us – food authenticity, mycotoxin contaminants, food additives, choking hazards and pesticides residues.

We continue to disseminate our learning from referee work via speaking engagements, our biennial conference, our website and through publication, appreciating in particular our collaboration with Professor Burns of the Institute of Global Food Security (IGFS) at Queen's University Belfast who continues to give generously of his time and experience in disseminating the outcomes of our work in the scientific literature. Such dissemination is a key measure of transparency in the discharge of the Government Chemist's responsibilities and we are further grateful to Norman Michie, editor of the open access Journal of the Association of Public Analysts where much of our technical output appears.

Table 1 Overview of referee cases in 2018

Inland Authority	Port Health Authority	Central Competent Authority	Dispute	Other*
3 (43%)	3 (43%)	1 (14%)	5 (71%)	2 (29%)

*Other includes SEO – Second Expert Opinion, pursuant to Article 35 of Regulation 2017/625 on *official controls*, or requests for assistance from other Government Departments or Local Authorities.



Food authenticity

Markers of authenticity are manifold. Some of the most informative can be DNA markers for species identification. However, simple organic compounds such as butyric acid can serve to authenticate butter while extensive datasets and profiles of sugars, sugar derivatives and other complex organic compounds may serve to authenticate honey. Natural variation is almost always a factor to be taken into account.

A relative newcomer in the analytical investigation of food authenticity is NMR spectroscopy. Its power to elucidate molecular structure is well known. However, its applicability to food authenticity studies stems from advances in instrumentation, ease of sample preparation, high reproducibility and the ability to identify and quantify markers in complex mixtures. Collection of NMR spectra is now usually a swift process and the ability to build databases of NMR “profiles” has, along with chemometric data analysis, allowed exploration of global food supply chains in a new and interesting way.

At the request of FSA and Defra, we have continued our investigation of analytical methods for honey authenticity. FSA and Defra are particularly interested in the use of NMR profiling methods to determine exogenous sugars in honey. Our efforts in this area are focussed on four work streams:

1 Collaboration with the European Commission Joint Research Centre (JRC)

An EU Coordinated Control Plan on honey adulteration⁶ indicated that a significant number of samples (20%) were non-compliant with authenticity criteria. A technical round table held at JRC attended by the Government Chemist team collected the opinion of a broad representation of stakeholders in the honey supply chain on the most common forms of honey fraud, the current challenges to authenticate honey and gaps in available tools and knowledge, and the needs for addressing them in an effective manner.

There was a focus on analytical methods to detect the addition of certain types of sugar (syrup) and non-authorised processing of honey. In addition, the need for effective infrastructures for the validation of analytical methods and the provision of quality assurance tools, and a desire for modernised purity criteria for honey going beyond the quality requirements laid down in current EU legislation, were addressed. Such criteria could take the form of an electronic collection of chemical fingerprints against which a suspect sample can be compared for assessing its authenticity and/or correctness of label declaration.

Analytical issues associated with honey profiling methods were discussed and significant concerns around suitability of current NMR methodology, and the integrity and coverage of the databases that it employs, were raised by some stakeholders. We continue to liaise with the JRC on an appropriate technical solution, recognising that both national and international efforts involving all relevant stakeholders will be necessary to address the gaps identified.

⁶ https://ec.europa.eu/food/safety/official_controls/food_fraud/honey_en

2 Independent critical review of the scientific literature

Working with Professor Duncan Thorburn Burns of the IGFS at Queen's University Belfast, we are reviewing recent scientific literature on honey authentication and NMR analysis. Our first joint output was an open access paper on methods for the determination of the authenticity of mānuka honey⁷.

3 Engagement with industry technical experts and stakeholders

We met several times with technical experts from the Bruker Corporation which offers commercial NMR honey profiling services. A visit to Bruker's "Biospin" facilities in Germany included an in-depth look at the scope of their method and its validation. We are grateful to Bruker for their openness and cooperation and continued discussions. Similar meetings with other NMR honey profiling service providers are planned.

We have also engaged in dialogue with a range of stakeholders including the British Retail Consortium (BRC) and the International Association for Monitoring and Quality Assurance in the Total Food Supply Chain (MoniQA⁸). At the second MoniQA conference on food fraud and allergen management, we presented "Honey authenticity: when official controls are questioned"⁹ and took part in a panel discussion on food authenticity.

4 Ongoing dialogue with FSA and Defra

We continue to update FSA and Defra on our activities and provide advice on specific questions related to honey authenticity and NMR.

Choking hazards – jelly confectionery

Instances worldwide of children and elderly people choking to death on certain soft slippery dome-shaped jellies designed to be placed in the mouth in one bite have drawn attention to a class of jelly confectionery known as jelly mini-cups. Food additive law¹⁰ bans the use of a range of gel-forming compounds in such products to avoid the possibility of "plugging" the airway. Disputes arise, less about the presence of the additives, but typically about the definition of the product in which they are banned.

The Government Chemist has been involved in assisting the authorities and businesses to interpret the relevant legislation. Our paper of 2012¹¹ remains the only published advice on how to test a product against the definition.

In 2018, a further imported consignment of jelly confectionery was impounded as it exhibited considerable variation from item to item. Some items clearly did not fall within the regulatory definition of a "jelly mini-cup" because they had very little structural strength. For others, it was at least questionable if they satisfied the definition owing to the ease with which they could be broken up. However, 60% of the items examined conformed to the Regulation definition and they contained one of the banned additives. Consequently the opinion was that the consignment was non-compliant.

In light of this referral, we are planning to deliver a practical knowledge transfer seminar on the issues surrounding these products during 2019.



⁷ Burns, D. T., Dillon, A., Warren J., Walker, M. J., 2018, A critical review of the factors available for the identification and determination of mānuka honey, *Food Anal. Methods* 11, 1561–1567

⁸ <https://www.moniqa.org/>

⁹ Walker, M., Honey authenticity: when official controls are questioned, 2018, *Quality Assurance and Safety of Crops & Foods*, 10 Supplement 1

¹⁰ Regulation (EC) No 1333/2008 of the European Parliament and of the Council of 16 December 2008 on food additives implemented in England by the Food Additives, Flavourings, Enzymes and Extraction Solvents (England) Regulations 2013 with devolved equivalents

¹¹ Walker, M. J., Colwell, P., Craston, D., Axford, I. P., Crane, J., 2012, Analytical strategy for the evaluation of a specific food choking risk, a case study on Jelly mini-cups, *Food Anal. Methods*, 5, 54-61

Food contact materials

To protect public safety, food contact materials (FCM) must neither transfer unwanted chemical components into food in unacceptable quantities nor alter the organoleptic properties of the food or drink. Safety limits are set in law on the transfer (migration) of specific compounds and there are also generic limits for non-specific, or overall, migration.

The thermosetting plastic melamine, is used to manufacture a diverse range of inexpensive FCM intended for repeated use. Melamine is a polycondensation product of the monomers formaldehyde and melamine, and residues of both may migrate from finished products. Both compounds are on the EU monomer positive list with specific migration limits. Formaldehyde, in particular, is an interesting example of a compound that can occur in food both from natural and man-made sources. Its toxicology is complex, being capable of sensitising some people to allergic contact dermatitis, and there is evidence that it is a carcinogen.

There have been alerts in the Rapid Alert System for Food and Feed concerning melamine products, imported from the People's Republic of China and the Hong Kong Special Administrative Region of China, releasing formaldehyde into food or food simulant above legislative limits. Thus Regulation (EU) No 284/2011¹² lays down conditions and procedures for the import of melamine plastic kitchenware from China.

A referee analysis was requested during 2018 on a sample of melamine plates which had been detained by a Port Health Authority due to alleged excess formaldehyde migration. However, our investigation demonstrated that formaldehyde migration from the tested plates was within allowable concentration levels.

Mycotoxins

Mycotoxins are naturally occurring secondary metabolites produced by moulds. Given their toxicity, and the propensity for some forms to cause cancer, stringent controls are in place to reduce human exposure. Disputes about concentrations of these toxins close to the legislative limits (low parts per billion) in imported consignments are a regular feature of referee casework (see previous editions of this review for further details).

2018 saw further disputes about the concentrations of ochratoxin A in a consignment of sultanas and aflatoxins in a consignment of Brazil nuts. In both cases, the findings of the Public Analyst were upheld and the consignments were prevented from entering the supply chain.

This action safeguards consumers from exposure to cancer-causing toxins and supports confidence and trust in the effectiveness and equity of the UK border control system in international food trade.

Pesticides

All foodstuffs intended for human or animal consumption must conform to maximum residue levels (MRLs) for pesticides in order to protect animal and human health. Generally MRLs are recommended by the European Food Safety Authority (EFSA) based on a risk assessment before being adopted into law. Where an MRL has not been specifically set, a "default" MRL of 0.01 mg kg⁻¹ is applied. Products must not be placed on the market as food or feed if they contain a pesticide residue exceeding the prescribed MRL or default level.

Modern pesticide residue analysis by specialist laboratories has progressed to a level where over 350 residues can be detected routinely in several concurrent analytical runs either by gas or liquid chromatography coupled with mass spectrometry.

In 2018, a pesticide residue, imazalil (a chlorophenyl substituted imidazole) (Figure 2), was reported in an animal feed described as "organic sunflower expeller [cake]". In fact, sunflower seeds containing imazalil would not be regarded as non-compliant unless the residue concentration was above 0.05 mg kg⁻¹. However, the presence of imazalil in a feed described as "organic" is not acceptable.

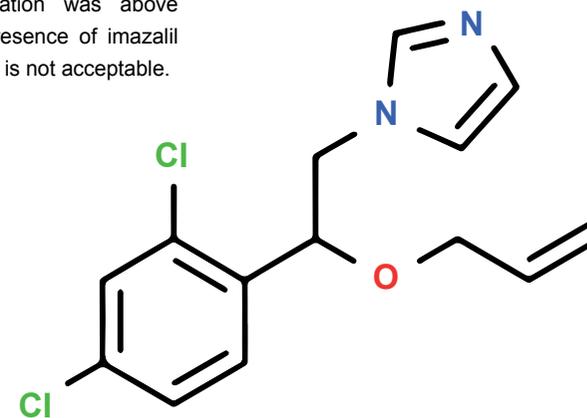
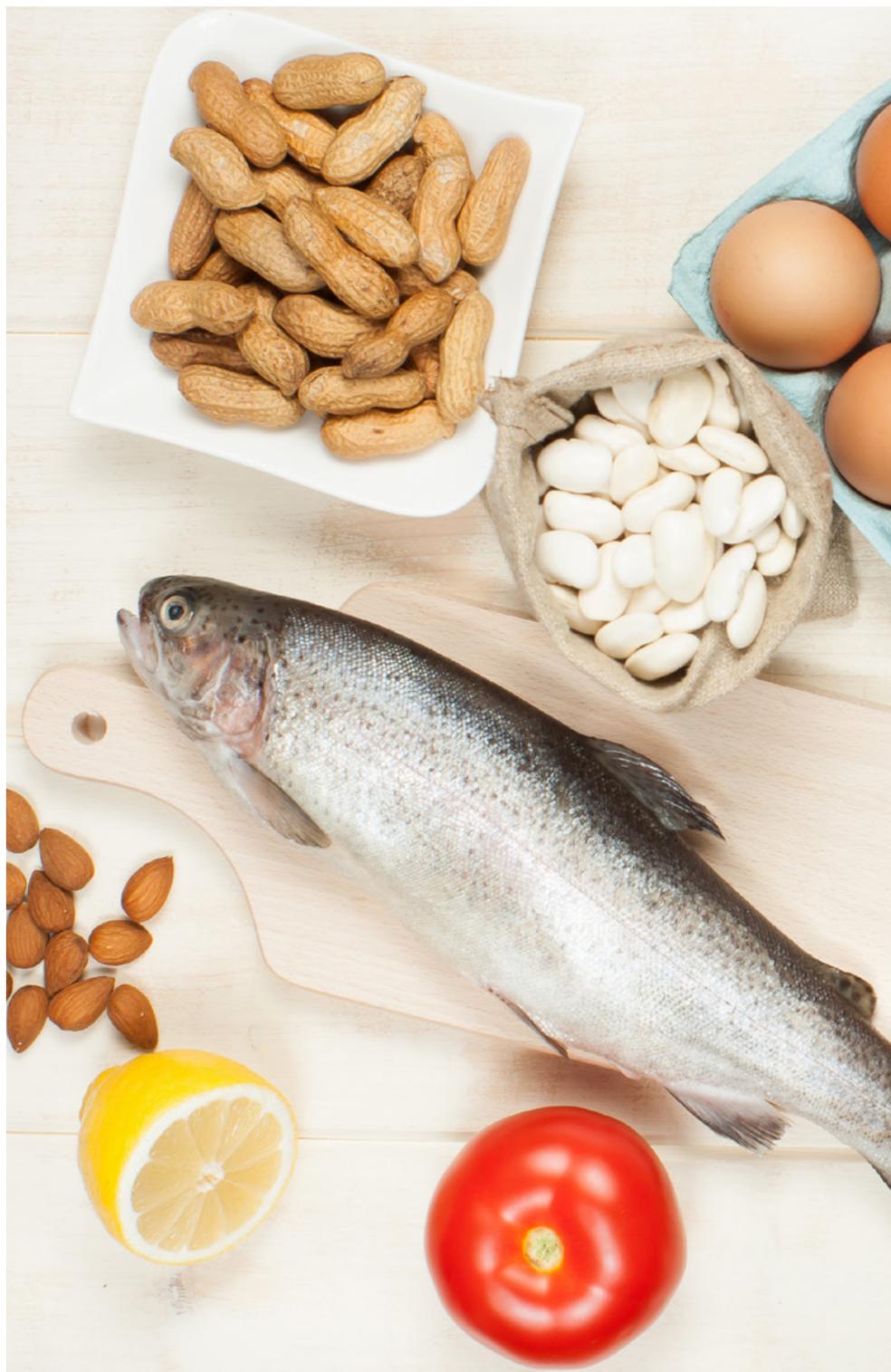


Figure 2: Structure of imazalil

¹² Commission Regulation (EU) No 284/2011 of 22 March 2011 laying down specific conditions and detailed procedures for the import of polyamide and melamine plastic kitchenware originating in or consigned from the People's Republic of China and Hong Kong Special Administrative Region, China



Investigation of the milled sample by gas chromatography coupled with mass spectrometry (GC-MS) was shown to provide insufficient analytical certainty. However, development of an acetonitrile/water QuEChERS¹³ extraction and clean-up followed by liquid chromatography coupled with tandem mass spectrometry (LC-MS/MS) was shown to be suitably selective and sensitive for imazalil.

An isotopically labelled internal standard¹⁴ was applied to yield inherent calculation of recovery. The method of standard additions was applied by fortifying separate aliquots with imazalil standard at the equivalent of nanograms per gram (ng g⁻¹). A reagent blank and instrumental (solvent) blanks, solvent standards and a reference material were included in the analytical batch. The run order was set up to avoid any potential carry over of imazalil. Six mass spectrometric transitions between precursor and product ions were available for imazalil and the analytical batch dataset was examined according to prescribed criteria for identification including retention time window, signal to noise ratio and transition ratio tolerances. Limits of detection (LoD) and quantification (LoQ) of 1.4 ng g⁻¹ and 4.3 ng g⁻¹, respectively, were established from six replicate injections of the referee sample fortified with imazalil at 10 ng g⁻¹ (0.01 mg kg⁻¹).

This detailed description of our approach will be of interest to practitioners especially because imazalil was not detected in the sample and the consignment was permitted to enter the supply chain.

In this instance, the consignment owner and analyst requested an opportunity to visit us after the case had been concluded to learn more about the background to the case, details of our analytical approach and to undertake a more general tour of our laboratories.

Vitamins

In the latter part of the 19th century and the early 20th century, work on beriberi associated the disease with the lack of a dietary component, coined “vital amines” when an anti-beriberi compound extracted from rice husks was shown to be an amine. The modern term “vitamin” recognises that such essential micronutrients are not always amines^{15,16}. The chemistry of vitamins is complex and the elucidation of their structures is a series of fascinating episodes in the history of chemistry.

For a referee case on one of the B vitamins received in 2018, legal proceedings are being considered and we must therefore await its conclusion before reporting any details of the case.

¹³ QuEChERS is an acronym for Quick Easy Cheap Effective Rugged Safe, an analytical approach that simplifies the analysis of pesticide residues with reduced susceptibility to errors and high recoveries. References: Anastassiades, M., Lehota, S. J., Stajnbaher, D., Schenck F.J., F. J., 2003, Fast and easy multi-residue method employing acetonitrile extraction/partitioning and dispersive solid-phase extraction for the determination of pesticide residues in produce, J AOAC Int, 86(2), 412-31 and British Standard BS EN 15662: 2018

¹⁴ 1-[2-(Allyl-d5-oxy)-2-(2,4-dichlorophenyl)ethyl]imidazole, imazalil-d5

¹⁵ Piro, A., Tagarelli, G., Lagonia, P., Tagarelli, A., Quattrone, A., 2010, Casimir Funk: his discovery of the vitamins and their deficiency disorders. Ann. Nutr. Metab., 57(2), 85-88

¹⁶ Coultate, T., Food: The chemistry of its components, 6th Edition, 2016, RSC Publishing, Cambridge

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 plastic particles in bottled water, allergen labelling or food contaminants. We answered over 75 requests for advice during 2018.



Number of enquiries by source

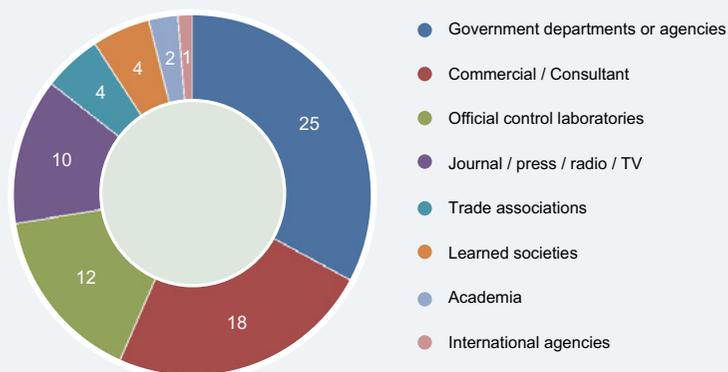


Figure 3 Distribution of enquiries by source

Number of enquiries by subject

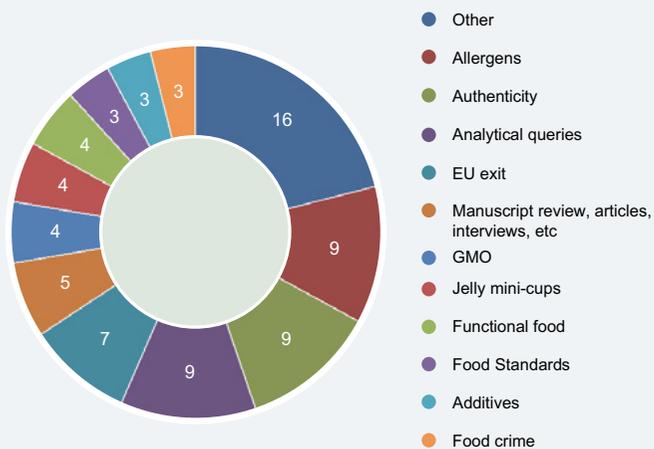


Figure 4 Distribution of enquiries by topic

Figure 3 shows the origin of the source of the enquiries. Figure 4 shows the breadth of enquiries across many topics – allergens, authenticity and measurement issues being amongst the most common, with the "other" category including enquiries on trace elements, sampling and sample preparation.

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

The enquirers are invariably grateful for our time and advice.

Expert opinion to stakeholders

Government Chemist staff also provide their expert input into a number of Committees (see Box 2) to influence the development of new legislation, standards and policy, and ensure that they are based on sound measurement science and are fit-for-purpose.

Increasingly, this year has been dominated by a number of different government departments seeking input into their risk assessments associated with EU Exit. These have included FSA, Defra and the Department for International Trade. However, expert advice has also been provided to the Institute of Food Science and Technology (IFST) Scientific Committee, the Association of Public Analysts (APA) Training Committee, the European Network of GMO Laboratories (ENGL) Steering Committee and the Food Authenticity Network

Management Committee, to name but a few. During 2018, the Government Chemist provided advice to Science and Advice for Scottish Agriculture (SASA), a division of the Scottish Government Agriculture and Rural Economy Directorate, on measurement uncertainty estimations for GMO analysis. The advice provided by Malcolm Burns will support analytical testing laboratories and promote a greater understanding of how to capture, report and express measurement uncertainty estimates.

The Government Chemist was contacted by a TV company seeking expert input to help with a feature about bottled water. Michael Walker provided advice as to why bottled water has a best before date, the difference in composition of "natural mineral", "spring" and "bottled" water and their microbial and mineral content, the issue of microplastics, and whether tap or bottled water was best, all within the context of the role of the Government Chemist.

Her Majesty's Revenue and Customs approached the Government Chemist to act as an independent advisor to review the suitability of their test methodologies for the determination of the tariff classification of foods specified in their contract for procurement of services. These discussions will continue into 2019.

Michael Walker represented the UK (FSA and the Government Chemist) at a closed meeting of the European Network of Food Allergen Detection Laboratories, Member State official laboratories and risk assessors, presenting on "Reporting requirements for food allergen measurement".

Box 2 List of committees to which the Government Chemist contributes

- Authenticity Methods Working Group (AMWG)
- Authenticity Steering Group (ASG)
- British Standards Institution Committee AW/275 – Food analysis – Horizontal methods
- British Standards Institution Committee AW/10 – Animal feeding stuffs
- European Committee for Standardisation (CEN) Food Authenticity Coordination Group (FACG)
- CEN workshop 86 – authenticity in the feed and food chain
- Codex Committee on Methods of Sampling and Analysis (CCMAS)
- European Network of GMO Laboratories (ENGL): Steering Committee & Plenary meetings
- Food Law Group
- Food Standards and Labelling Focus Group
- Hazardous Substances Advisory Committee (HSAC)
- Institute of Food Science and Technology (IFST) Science Committee
- MChemA Exams Board Meeting
- University of Manchester Allergy Network (MFAN)
- Nanomaterials Environment and Health Industry Group (NEHIG)
- Nanomaterials Environment and Health Government Group (NEHGG)
- Royal Society of Chemistry (RSC) Analytical Methods Committee (AMC) Nitrogen Factors Sub-Committee
- Royal Society of Chemistry (RSC) Food Group
- Standing Committee of Analysts (SCA) board
- UK Chemicals Stakeholder Forum (UKCSF)

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.

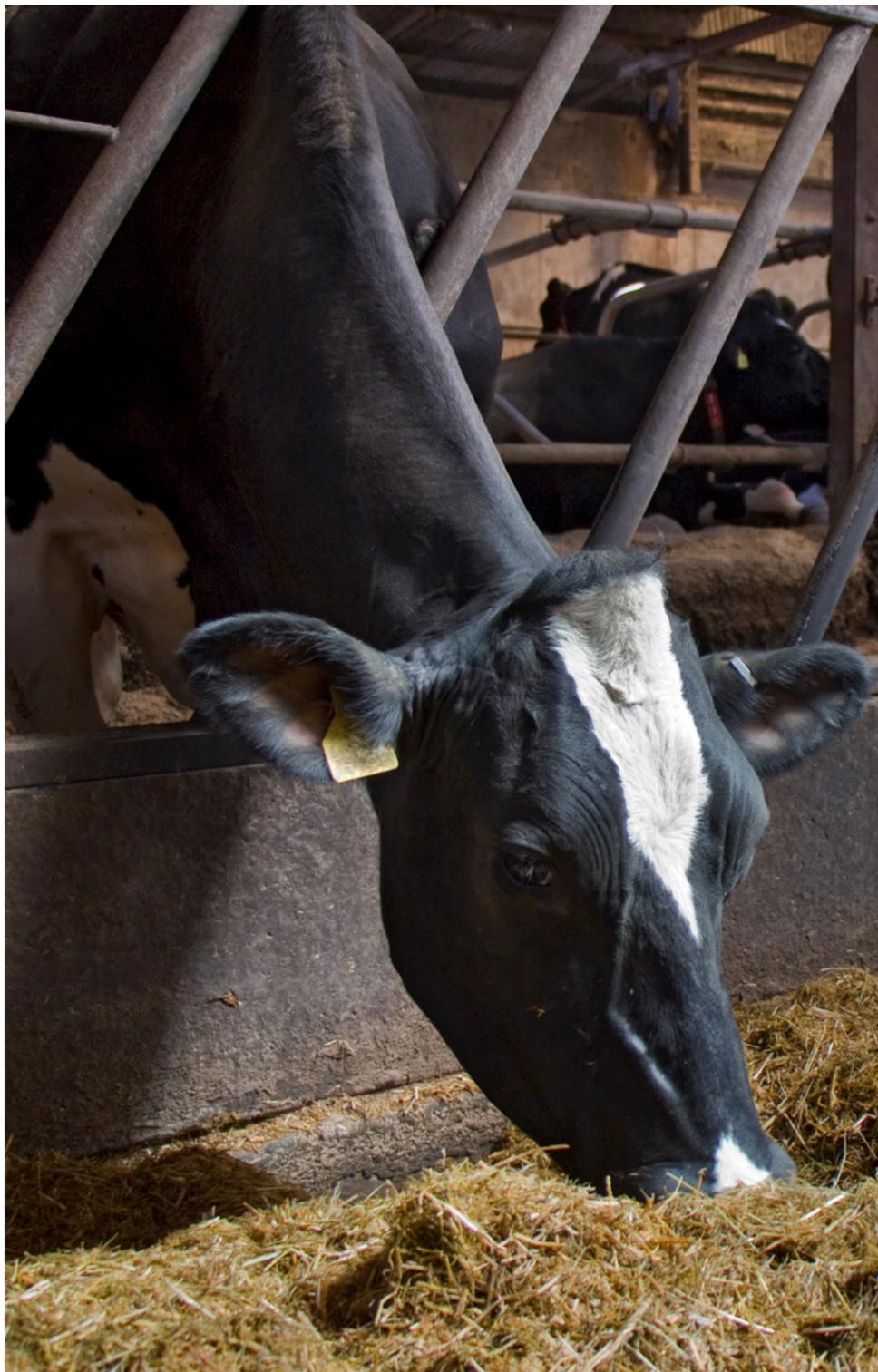
The Government Chemist has continued to provide input to these official consultations, being well placed through the additional expertise it can draw upon from within the National Measurement Laboratory (NML) and the wider LGC organisation across a range of analytical science, to respond authoritatively and independently where the consultations have chemical or bioanalytical measurement implications.



The full list of the consultations responded to by us during the year is shown in Box 3, a selection of responses are available at www.gov.uk/governmentchemist.

Box 3 Consultations to which the Government Chemist has responded

- The Food Law Code of Practice (Wales) Review 2018
- Post Implementation Review (PIR) of the Food Safety (Sampling & Qualifications) (England) Regulations 2013
- EFSA DRAFT for Public Consultation: Guidance on risk assessment of the application of nanoscience and nanotechnologies in the food and feed chain: Part 1, human and animal health
- Healthy and Sustainable Food for London – Draft for Consultation by the Mayor of London
- Regulating Our Future – amendments to the Food Law Code of Practice (England)
- Regulating Our Future – amendments to the Food Law Code of Practice (Northern Ireland)
- The proposed Materials and Articles in Contact with Food (Wales) (Amendment) Regulations 2018
- The Food and Feed (Miscellaneous Amendments and Revocations) (Wales) Regulations 2018 Consultation
- Defra “Health & Harmony” white paper consultation
- Defra consultations amending domestic food legislation to ensure that a range of provisions can continue to operate after the UK has left the EU



Horizon scanning

Legislation updates

Maintaining a watch of developing issues and relevant regulatory updates helps us to be aware of future challenges. The quarterly published “Compendium of UK food and feed legislation updates” which may be found at www.gov.uk/government/chemists includes contextual information on legislative changes. During 2018, these reports included information related to the preparations for the UK’s exit from the EU, FSA and Defra activities, and provided an international dimension through updates on Codex, the Food and Agriculture Organization of the United Nations (FAO), the World Health Organization (WHO) and the US Food and Drug Administration (FDA).

Additionally, we continuously monitored changes to documentary standards published by the European Committee for Standardisation (CEN) and published summaries of the changes to chemical measurements in support of food and animal feed regulation, on our website at: www.gov.uk/government/chemists.

Gene editing – implications for food and feed analysis

This year saw case law from the Court of Justice of the European Union (CJEU) relating to genome editing techniques. Their ruling on 25 July, that products of gene editing (synthetic biology) should fall under the pre-existing legislation for detection and labelling of GMOs, is likely to put a huge analytical burden on those laboratories tasked with testing for, and identifying, products arising from new gene editing approaches.

Most mutations induced by new gene editing technologies cannot unequivocally be distinguished from natural mutations or from those produced by conventional mutagenesis techniques which have been incorporated in traditional plant breeding programmes. In the absence of prior knowledge on the genome-edited changes, and with the current analytical capabilities of enforcement laboratories, there is a reasonable likelihood that non-authorized products obtained by genome editing could enter the EU and UK markets undetected. The implications for analytical workflows and techniques therefore need to be looked at in further detail.

Malcolm Burns is contributing towards an explanatory note on the topic of detecting issues for products originating from new gene editing approaches (synthetic biology) which is being drafted by the EU Reference Laboratory (EURL) at the EC JRC following a request from DG SANTE. Other members of the Government Chemist team are also providing guidance through the Engineering Biology Advisory Committee of the BioIndustry Association (BIA).

5

Impact of our work

The impact of the work of the Government Chemist programme is broad and the effects can be seen 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.



Our capability building research 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, generating chemical and bio-measurement capabilities for use in referee cases and for adoption by stakeholders, and by predicting future regulatory issues.

Building new capabilities

Developing extraction methods for mycotoxins

Mycotoxins are carcinogenic secondary metabolites which appear in food as a result of fungal contamination in the field or during storage. The maximum levels of mycotoxins allowed in food for human consumption are set in Europe by the Commission Regulation 1881/2006¹⁷ and the Commission Recommendation 2013/165/EU¹⁸ (see Table 2).

Due to the structural diversity of mycotoxins and the complexity and variety of food matrices in which they occur, their simultaneous determination

at low concentrations is challenging. Furthermore, current mycotoxin methods used for official control purposes appear not to detect conjugated or non-extractable mycotoxins – known as “masked” mycotoxins. Although masked mycotoxins are in principle less toxic, evidence now suggests that they can be converted to the toxic form in the mammalian gut.

It is anticipated that this evidence may prompt the setting of regulatory limits for masked mycotoxins. In preparation for such eventuality, the Government Chemist team has been building on previously developed mass spectrometry capabilities to increase the scope of current

methods based on QuEChERS (Quick Easy Cheap Effective Rugged Safe) extraction followed by LC-MS analysis, to include mycotoxins and masked mycotoxins. The QuEChERS method is a streamlined approach that was developed initially to make it easier and less expensive to examine pesticide residues in food. While it has been adapted successfully for the analysis of mycotoxins, the methods have often been applied to one single type of food. To support Government Chemist referee cases relating to mycotoxins, it would be greatly beneficial to have an approach for screening different food matrices.

Table 2 Summary of limits set by European legislation for mycotoxins in food for human consumption

Legislation	Mycotoxin	Food commodity	Limits (range for human consumption) [$\mu\text{g kg}^{-1}$]
Commission Recommendation 2013/165/EU	T-2, HT-2 (sum of)	Cereals, cereal products	15 (baby food) 25–200
Commission Regulation 1881/2006	Aflatoxins	Nuts, peanuts, almonds, pistachios, dried fruits, cereals, spices, milk	0.1 (B1 in baby food) 2–8 (B1) 4–10 (sum of B1, B2, G1, G2) 0.050 (M1 in milk)
	Ochratoxin A	Cereals, dried fruit, coffee, wine, grape juice, spices, liquorice	0.50 (baby food) 2–80
	Patulin	Apple, apple juice, cider	10 (baby food) 10–50
	Deoxynivalenol	Cereals, cereal products	200 (baby food) 500–750
	Zearalenone	Cereals, cereal products	20 (baby food) 50–400
	Fumonisin	Maize	200 (baby food) 800–1000
	Citrinin	Rice	2000

¹⁷ Commission regulation (EC) No 1881/2006 of 19 December 2006 setting maximum levels for certain contaminants in foodstuffs (Text with EEA relevance) (OJ L 364, 20.12.2006, p. 5)

¹⁸ Commission recommendation of 27 March 2013 on the presence of T-2 and HT-2 toxin in cereals and cereal products (Text with EEA relevance) (2013/165/EU)

The application of QuEChERS involves using a combination of salts and clean-up sorbents to extract the analyte of interest prior to detection, in this case, with high resolution mass spectrometry (HRMS). The project team examined a range of combinations of salt and sorbents and their efficacy at extracting the mycotoxins in a selection of matrices, which included maize flour, beer, whole breakfast cereals, whole wheat semolina, penne pasta, brown bread, cornflakes, brown wheat flour, oats, whole black peppercorns and peanuts (whole and ground).

Satisfactory results were obtained for cereal products and nuts. Good detection at low levels was achieved for all legislated mycotoxins, with the exception of Ochratoxin A for which further work is required to establish unequivocal detection at the required concentrations. Additional work is also needed to identify extraction and clean-up methods for mycotoxins in spices. The chosen methods should be applied to spices on a case-by-case basis due to the great variety of different matrices (dried herbs, berries, grains, nuts, powdered dried fruits, etc.) which can produce interferences for specific compounds or give rise to "dirty" extracts with increased background.

Based on the results obtained, a general analytical strategy (Figure 5), with different workflows, is being tested for the simultaneous screening of mycotoxins in a variety of food matrices¹⁹ susceptible to mycotoxin contamination. This strategy represents

an alternative to existing methods, which tend to involve time consuming clean-up methods, and are typically targeting specific mycotoxins.

The use of HRMS has been shown to allow untargeted analysis and to interrogate the results for analytes for which control standards are not available, such as masked or modified mycotoxins.

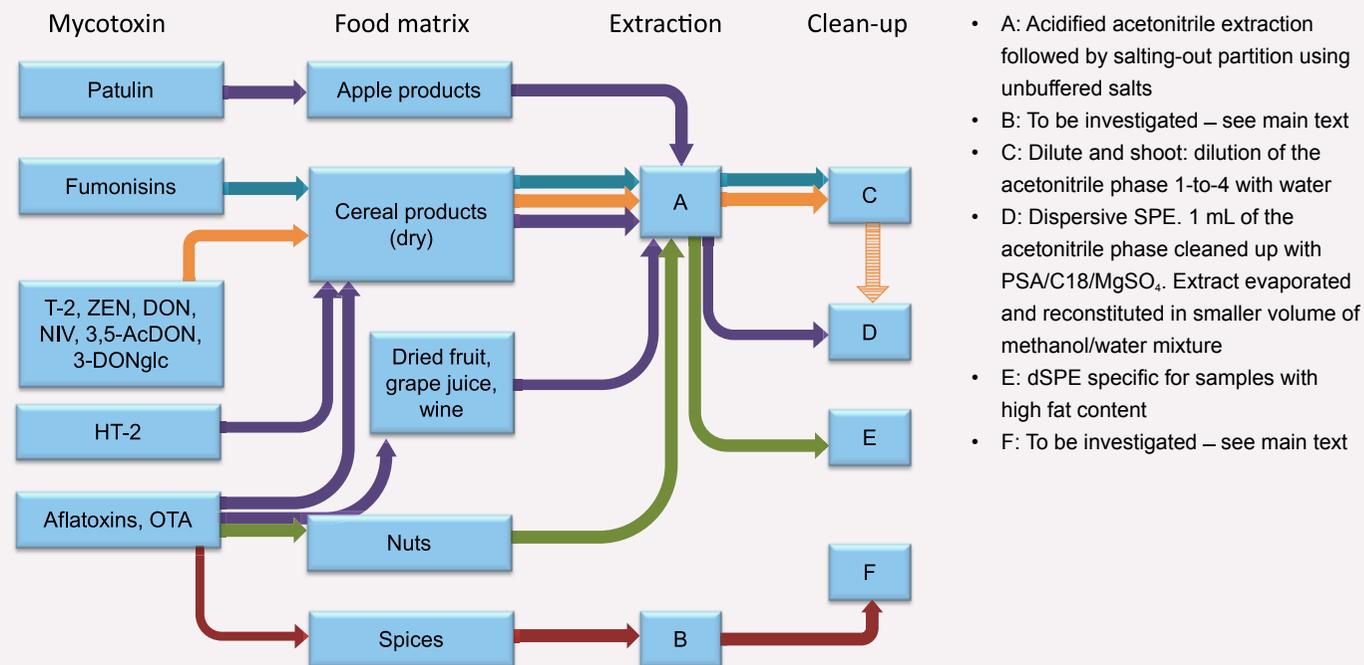


Figure 5 General plan for the extraction and clean-up by QuEChERS of different mycotoxins in different commodities

¹⁹ Some of the matrices in this figure have not been tested using this approach, such as apple and dried fruits



Molecular biology approaches for food analysis

Modern molecular biology approaches (including PCR, quantitative real-time PCR, DNA sequencing (Sanger and Next Generation Sequencing) and digital PCR) support successful food testing to help consumers make informed choices on the food they eat. The continued development and maintenance of the Government Chemist DNA capability-building projects in this area has underpinned the successful resolution of a number of key referee cases in both past and present programmes. To further maintain, enhance and add value to our competency in this area, the team is working on a project focused on the application of the core DNA-based molecular biology approaches across all areas of meat, fish, GMOs, plants (including herbs and spices) and allergen testing.

The project aims to consolidate the previously separate molecular biology based approaches and significantly reduce costs. Project outcomes include guidance on:

- New and emerging approaches for food analysis, inclusive of development of novel assays for specific species of topical importance (e.g. nuts, herbs and spices);
- New and emerging approaches for food analysis including approaches for absolute single molecule detection (digital PCR);
- Providing improved confidence in DNA sequencing and DNA databases using bioinformatics approaches;
- Approaches for detecting products of new (plant) breeding techniques and products of synthetic biology (e.g. as a result of CRISPR-Cas9 genome editing).

During 2018, progress was made against all these outcomes. The Government Chemist function contributed to a draft European Commission guidance document entitled "Overview and recommendations for the application of digital PCR" which has been completed by the European Network of GMO Laboratories (ENGL) Working Group. Once approved by the ENGL Steering Group, the guidance document will be placed in the public domain in 2019. The document provides an overview of digital PCR (both chamber based and droplet), fields of application, theoretical basis, statistics and assumptions, quality metrics, data interpretation and reporting, and costs and practicability. This will be the first publication of EC guidance on the use of digital PCR (with specific application for GMO analysis) and will be pivotal in helping set quality acceptance criteria for using the

technique across many areas of food authenticity testing and quantitation.

Our ISO/IEC 17025 flexible scope of accreditation for GMO analysis is in the process of being upgraded to the latest equivalent real-time PCR machine, the Applied Biosystems™ QuantStudio™ 7 Flex Real-Time PCR System (QS7). Its validation for GMO and other food analyses will be completed during 2019.

The Government Chemist is also providing input into revision of the JRC "Guidance Document on Measurement Uncertainty for GMO Testing Laboratories". This revision includes current thinking on measurement uncertainty estimation and use of new technologies, and is being rewritten as a more streamlined "how to" document for laboratory implementation. The document is due to be published during 2019.

Staff of the Government Chemist team are further contributing towards editing and providing authorship on chapters and case studies for an RSC book entitled "DNA techniques to verify food authenticity".

Sharing and transferring knowledge

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

Case studies

The Government Chemist publishes case studies to highlight key technical findings and provide stakeholder guidance, especially in recurring topics. During the year we published a number of case studies, including a number relating to available factors for the identification and determination of mānuka honey.

Burns, D.T., Dillon, A., Warren, J., Walker, M.J., A critical review of the factors available for the identification and determination of mānuka honey

Burns, D.T., Walker, M.J., Gordon Wickham Monier-Williams OBE, MC, MA, PhD, FRIC (1881-1964) A major contributor to the improvement in quality and purity of foodstuffs via his professional influences and innovations in analytical chemistry

Walker, M., Honey authenticity: when official controls are questioned, 2018, Quality Assurance and Safety of Crops & Foods, 10 Supplement 1

See the publications list on page 26 for full references.

Government Chemist conference

Over 100 delegates from 50 organisations attended the 2018 Government Chemist Conference at BMA House on 13 and 14 June to hear experts discuss the challenges of providing food and drink for the public that is authentic, safe and sustainable.

After hearing the Government Chemist open the conference, the BEIS Chief Scientific Advisor, Professor John Loughhead, provided the keynote lecture on the current challenges in the provision of food that meets the needs of customers in terms of affordability, safety and authenticity at a time of global change. As well as geopolitical change, scientific advances and shifting attitudes are contributing to create a complex scenario for all stakeholders in the food and drink space. He explained how different departments within BEIS are working together, and with the newly created Food and Drink Sector Council, to develop and support a regulatory landscape that ensures the delivery of those customer requirements. The recent Government Chemist referee work was presented by Michael Walker.

Other key international presentations across the two days included a talk by Franz Ulberth from the EC JRC on the work they are doing to combat the global issue of food fraud, a theme that was expanded upon by Chi Singh Ng from the Government Laboratory in Hong Kong in his talk titled "Food Safety Challenge – Hong Kong perspective".

The conference report and presentations are available from www.gov.uk/governmentchemist.





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 2018, 35 articles including news and reports, were published on the Government Chemist webpages, which have been viewed in approximately 27,000 unique visits. The most frequently accessed documents are the quarterly updates on food and feed legislation, the Government Chemist review and articles about training events.

Training

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

Postgraduate summer school in the Analysis and Examination of Food

The annual week-long postgraduate course organised by the Government Chemist on behalf of the APA Educational Trust offers a distinctive learning experience, validated by active

practitioners in the APA Training Committee. This year it attracted a further 16 delegates, eight from England, four from Scotland, two from Wales and two from Gibraltar. The delegates represented public (nine) and private (four) sector Public Analyst laboratories, alongside a research institution (one), an academic (one) and a Trading Standards Department (one).

The lectures, delivered by senior academics, Public Analysts and government policy officials, covered food authenticity, microbiology theory and laboratory practical microscopy tuition, toxicology, drinking and bottled water quality, contaminants, food contact materials and food packaging taints. An evening session offered training in foreign body identification. Vicki Barwick from LGC contributed a well-received tutorial on measurement uncertainty.

The course was supported by FSA, Defra and the RSC Analytical Chemistry Trust Fund (ACTF). It was organised and facilitated by Michael Walker and Kirstin Gray and received very positive feedback:

- 'Content very good, useful information, interactive session good and hands-on experience increases confidence'
- 'Massively interesting content, delivered very well by interesting people – true experts in their fields.'
- 'Great style of presentation.....making a potentially dry subject really interesting'
- 'A lot of information very well presented.'

Publications

Publishing peer reviewed papers is integral to our work enabling transparency to the analytical community. A selection of papers published in 2018 include:

McCullough, B., Hopley, C., A validated LC-HRMS method for the detection of T-2 and HT-2 toxins in cereals, 2018, J Assoc. Public Anal., 45, 041-073

Burns, D.T., Walker, M.J. Mussell, C., Chondroitin sulfate: A critical review of generic and specific problems in its characterization and determination – An exemplar of a material with an unknown or variable composition (UVCB), 2018, J AOAC Int., 101(1), 196-202

Burns, D.T., Dillon, A., Warren, J., and Walker, M.J., A critical review of the factors available for the identification and determination of mānuka honey, 2018, Food Anal. Methods, 11, 1561-1167

Burns, D.T., Walker, M.J., Gordon Wickham Monier-Williams OBE, MC, MA, PhD, FRIC (1881-1964) A major contributor to the improvement in quality and purity of foodstuffs via his professional influences and innovations in analytical chemistry, 2018, J Assoc. Public Anal., 2018, 46, 9-19

Walker, M., Honey authenticity: when official controls are questioned, 2018, Quality Assurance and Safety of Crops & Foods, 10 Supplement 1

Burns, D.T., Walker, M.J., Joan Davena Peden (1920-1997). An exemplar public analyst and the first female president of the Association of Public Analysts, 2018, J Assoc. Public Anal., 46, 32-40





Engagement with stakeholders

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

Selvarani Elahi was invited to attend the 24th meeting of the Food Import and Export Inspection and Certification Systems (CCFICS) in Brisbane, Australia, as part of the UK delegation to give a presentation on the Food Authenticity Network²⁰.

The meeting was attended by over 40 member country organisations interested in the model constructed for the UK and EU. Follow-on discussions are now in progress to develop bespoke pages for interested countries.

Selvarani also hosted a meeting of the Food and Drink Federation (FDF) Food Safety and Scientific

Steering Group on 27 September at LGC. The event started with an introduction from Julian Braybrook, and Malcolm Burns gave a demonstration of the Scio™ (pocket sized NIR spectrometer) applied to oregano testing.

Julian Braybrook met the Medicines and Healthcare products Regulatory Agency (MHRA) to discuss the potential for a broader advisory function to MHRA through the creation of a UK Standards Liaison Group for Advanced Therapies (future medicines).

Julian Braybrook and Paula Domann met the Leader of the House and Chief Whip for the Welsh National Assembly, and the Chief Scientific Advisor for Wales. Julian was introduced as the new Government Chemist and discussed the life science strategy priorities for Wales. Follow-up actions have been identified as part of the Government Chemist advisory role.

²⁰ <http://www.foodauthenticity.uk/>

Areas of collaboration with stakeholders

It is clear that collaboration with other organisations with common or complementary interests not only helps us discharge our roles efficiently, but also contributes to a more rapid development and implementation of methods and standards for all. During 2018 we engaged with a wide range of stakeholders on a variety of topics.

Food allergens

The Government Chemist has a long standing interest in food allergen analysis. Our interest focuses on the three areas of:

1. Metrologically traceable food allergen analysis (the science of ensuring allergen measurements agree from one laboratory to another across the globe).
2. Resolution of analytical disputes about allergen measurement (referee cases).
3. Food allergen management – to better understand industry best practice in order to interpret allergen measurement results in the right context and offer advice to businesses, regulators, enforcement authorities and consumers on request.

In particular, this year's efforts have focussed on collaboration with:

- Hazel Gowland, founder of Allergy Action, who supports and advises those at risk from severe food allergies, both through personal experience and professional expertise. She works with food suppliers, local and national government, clinicians and other stakeholders to improve the safety and quality of life of those

with food allergies. We have been working with Hazel to better understand the forensic aspects of failed allergen avoidance that have led to fatalities or near misses and resulted in prosecutions or litigation. We have also collaborated with Hazel on the IFST Scientific Committee, working on revisions to the Food Allergy Information Statement, which outlines scientific developments, regulation and other relevant information and surrounding matters of topical importance within food science and technology.

- Prof Clare Mills, Chair in Allergology at the University of Manchester, who runs the influential Manchester Food Allergy Network (MFAN). This network meets regularly to bring international stakeholders such as ELISA kit manufacturers, analytical service providers, regulators, retailers and food businesses together to discuss problems, research on food allergy and agree on solutions. We have been contributing to talks and ideas, and host MFAN meetings fostering collaboration and scientific publications in this key area.
- MoniQA, an international and interdisciplinary network of professionals from institutions working in food research, regulatory bodies and trade, providing solutions to promote a safer and secure food supply worldwide. We have been collaborating with MoniQA both to contribute to, and learn from, its acclaimed international annual conferences. This year, Michael Walker represented the Government Chemist at the second MoniQA conference on food fraud and allergen management in

Vienna. An overview of the conference can be found at <https://www.moniqa.org/>

- Professor Duncan Thorburn Burns, Professor Chris Elliott and Dr Katrina Campbell at the Institute for Global Food Security (IGFS), Queen's University Belfast. Professor Burns provides a wealth of experience in forensic analytical chemistry and mentors researchers in the Government Chemist programme. In exchange, we provide informal joint supervision of undergraduate students final year projects. These activities have led to well received scientific publications. We have contributed to the annual seminar on food allergen analysis established by Dr Campbell and have maintained our informal link with Professor Elliott on food authenticity for which he is a globally renowned expert.

Point-of-test devices for food testing

Scotch Whisky Research Institute (SWRI)

Our project "Rapid and Point-of-Test Devices for Food Testing" aims to evaluate the potential of transportable mass spectrometry in a food production environment. The Scotch Whisky Research Institute (SWRI) supplied approximately 90 whisky distillates for analysis. The data generated is being evaluated using the data analysis tools developed under the National Measurement Laboratory's Chemical and Biological Metrology Programme, demonstrating the synergistic nature of this programme with that of the Government Chemist and the benefit of the





obtained on the whisky distillates will be compared to an SWRI flavour wheel and distillates will be selected for ageing (minimum 3 years) in barrels.

OLEUM

The applicability of direct ambient ionisation mass spectrometry to food authenticity is being demonstrated by analysis of authentic virgin olive oil samples received from the EU OLEUM²¹ project²².

Oregano adulteration

Both the Multi Spectral Imaging (MSI) instrument and Scio™ (pocket NIR spectrometer) that are being evaluated in the Government Chemist Programme project “Rapid and Point-of-Test Devices for Food Testing” will be used as part of the on-going international trial on the gross adulteration of oregano, involving 30 laboratories worldwide. It is envisaged that this trial will provide an excellent opportunity to compare the results obtained from these technologies with those obtained from other laboratories using other techniques.

DNA Extraction

The EC Joint Research Centre

Malcolm Burns, as part of a European Commission Working Group, is developing best practice guidance on the principles of DNA extraction, available international standards, method scope and validation, and quality assessment associated with DNA extraction for food analysis.

Food authenticity

The Head of the Food Fraud & Quality Knowledge Centre at the EC JRC, Franz Ulberth, is a member of the Management Committee for the Food Authenticity Network (FAN). The FAN offers a one-stop-shop on food authenticity testing and food fraud mitigation so that best practice is shared globally which will ultimately lead to increased consumer trust in the food they buy and help support a competitive and resilient food supply.

Since its launch in July 2015 the FAN has been recognised at a Codex Alimentarius Commission meeting as a 'leading example of an integrity network' and is given in the meeting report as a 'relevant resource'. Although, its origins were in the UK, the network is growing globally; it now has over 1000 members from 55 different countries with approximately as many non-members also accessing the resource.

To aid global growth, from January 2019, the FAN will transition to a public-private partnership led by the National Measurement Laboratory (NML) who will work with international regulators, and the food industry to secure continued ongoing support.

²¹ <http://www.oleumproject.eu/>

²² The OLEUM partners have identified four main gaps in the current knowledge that the project will address: legislation and regulation, analysis, harmonisation and coordination, consumer and market confidence



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