2016

Government Chemist

Review 2016

Department for Business, Energy & Industrial Strategy

FUNDED BY BEIS

“Over its long history the Government Chemist has shown that it is possible to rise to most measurement challenges”

CONTENTS

FOREWORD

I am pleased to report that in 2016 the Government Chemist function continued to promote the importance of good forensic analysis in assuring consumers about the provenance, authenticity and safety of the food they consume. This is a theme that was highlighted in the 2015 annual report of the Government Chief Scientist Advisor, titled 'Forensic Science and Beyond'; in our biennial conference held in June at the Royal Society, London; and through the referee work that is described in this review.

As in prior years, we received a diverse range of referee analysis work during 2016 which included measurement disputes relating to mycotoxins, authenticity, protein allergens and sulphites. The resolution of most of these disputes drew on knowledge that was developed as part of previous capability building activities, and on our detailed approach to the associated measurement which involves multiple repeats and often more than one method of analysis. We are very conscious of the need for timeliness in reporting our work and hence the importance of preparedness in predicting future issues, and in ensuring that we have appropriate means for responding. This review highlights some of this work, both in horizon scanning, and in assessing the related risks and methods for measurement. It includes discussions on the use of molecular biology methods in studies of emerging issues in the authenticity, integrity and analysis of herbs and spices, and the recovery of protein allergens from processed food for immunoassay and mass spectrometry quantification.

While it is very difficult to accurately predict future referee needs, every three years we go through a detailed process of consultation with academia, industry and government. During this consultation we consider market trends, risks and emerging regulation to define where we need to build expertise to continue to respond effectively in areas of measurement dispute. This exercise leads to a list of development requirements which is further prioritised by the Government Chemist Programme Expert Group (GCPEG). We have just completed this exercise and consequently over the next three years we will be investing further in developing our capabilities in genetic, protein and rapid testing methods for food and agricultural products. The outputs of this work will not only enable us to respond faster and more flexibly when measurement disputes emerge but will also be disseminated widely with a view to broader adoption by government, and commercial and industrial laboratories. Dissemination and advisory activities form a very important part of our work and involve a range of actions including publishing research outputs, responding to scientific and regulatory consultations, providing input to technical committees and maintaining an up-to-date website with regular news postings.

Finally, in introducing this review, I would like to thank the individuals responsible for delivering the work of the Government Chemist, and the Department for Business, Energy and Industrial Strategy (BEIS) for their continued support of the function. This report forms part of our advisory and dissemination activities and, as ever, I welcome your feedback on its contents.

Derek Craston
BSc, PhD, Hon.DPhil, FRSC
Government Chemist

It is my pleasure to contribute to the 2016 Government Chemist review as Chair of the Government Chemist Programme Expert Group (GCPEG).

The primary function of the GCPEG is the governance of the Government Chemist programme. This expert group comprises key stakeholders representing regulation and policy makers, industry, public analyst laboratories, port health authority, and academia. The GCPEG meets twice a year to provide independent oversight of the ongoing referee casework programme, research projects and advice given by the Government Chemist, and also reviews the quarterly progress reports.

At the time of writing this review, LGC, the home of the Government Chemist function, will be in its 175th year of existence. Looking over the evolution of the causes of disputes, it is evident that as global trade has increased, referee cases have reflected an ever expanding range of issues. The increasing complexity of modern measurement is a key challenge for the Government Chemist and his team; often a multi-method approach combined with rigorous forensic discipline is required to produce results and advice stakeholders can rely on. Additionally, regular horizon scanning activities and reviews of forthcoming issues help focus where capability needs to be built and maintained to be able to respond in a timely and effective manner.

It is clear that the Government Chemist and his team have responded magnificently to these challenges with the work carried out over the past year. Over its long history, work carried out under the Government Chemist programme has shown that it is possible to rise to almost any measurement challenge resulting from modern trading conditions. Notwithstanding the requirement to deliver, the team is always conscious of the need to undertake work that is fit for the purpose at a reasonable cost. By leveraging expertise acquired in previous programmes and across LGC, the Government Chemist team ensures that we all get a high return for our investment in the regulatory role.

This review demonstrates the excellent science carried out to address such measurement challenges, and how it underpins UK food law. The Government Chemist and his team always aim to fulfil their role, not just with professionalism, but with passion to deliver dependable referee case results, advice and research outputs. I am sure all stakeholders will both enjoy and value the review.

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

1 REMIT

The Government Chemist role was created 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.

The Government Chemist has always used up-to-date and authoritative measurement procedures coupled with interpretative skills to act as a fair and independent arbiter to resolve disputes, to provide public protection and to contribute to effective and efficient regulatory enforcement in industrial sectors where chemical measurements are important. The need to develop measurement techniques and procedures both within our own laboratories and in collaboration with other expert organisations continues to exist. This will enable the Government Chemist to respond to future issues as and when they arise.

The Government Chemist fulfils statutory and advisory functions, both of which are funded by the Department for Business, Energy and Industrial Strategy (BEIS).

Statutory function

The Government Chemist has a statutory function comprising science-based duties prescribed in seven acts of Parliament. These duties (see Box 1 on page 9) cover public protection, safety, health, value for money, and consumer choice. The resolution of scientific disputes is a cornerstone of our activities – the most important aspect of what we do – and is usually called 'referee analysis'. Our role is in the resolution of disputes between regulators and businesses and is based on our independent measurements, interpretations and expert opinions. A successful resolution often avoids recourse to legal process which reduces the burden on public finances. Many of these cases are important and can have a significant impact on either or both parties, as well as potential consequences for industry and regulation in general. 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 assignment of our home laboratory, LGC, as the National Measurement Laboratory and Designated Institute for chemical and bio-measurement.

Legislation covering the food, agriculture and medicinal products sectors, where the safety and protection of the consumer is of prime importance, contains equivalent provisions for the taking of official samples and subsequent analysis.

There are several routes for referral to the Government Chemist. The main route is the Food Safety (Sampling and Qualifications) (England) Regulations 2013 (and their equivalents in Scotland, Wales and Northern Ireland), which are invoked for many of the dispute resolution activities we undertake. These regulations state that all test samples are divided into three parts by an authorised officer. The enforcement authority and Food Business Operator (FBO) – 'the trader' – each receive one of these samples to perform independent analyses, while the third part of the sample is retained in case there is a dispute requiring the Government Chemist to act as referee.

FBOs may also, in some circumstances, request a referral to the Government Chemist without having their own portion of the sample analysed. This procedure is known as 'supplementary expert opinion' and is described on our website[1].

[1] https://www.gov.uk/guidance/submit-a-supplementary-expert-opinion-sample

For businesses, a successful appeal to the Government Chemist may avoid the effects of penalties prescribed under criminal law, potentially expensive compliance actions and, most seriously, loss of reputation and goodwill. Lastly, the referral sometimes comes from the court itself, with proceedings suspended pending the outcome.

The Government Chemist also acts as a source of advice for government and the wider analytical community and in some instances we are asked by government to resolve a dispute when a formal sample has not been taken.

When the Government Chemist's findings confirm those of the enforcement authority, the appropriate action to protect the public can, of course, proceed with increased authority. But, regardless of the outcome, the scientific outputs of the case are disseminated to all parties so that lessons are shared, which if taken on board should hopefully help reduce the possibility of recurrence.

Dissemination of referee cases also takes place through scientific publications, the Government Chemist conference, seminars, workshops, training events and via our website[2].

► **Section 2 of this review looks at the year's completed referee cases.**

The need for referee analysis is often greatest 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. New methods need to be developed and validated to accommodate that need. The Government Chemist carries out research and development (R&D) in the form of capability building projects based on horizon scanning which identifies the areas where this is most likely to occur. The outputs of these studies are disseminated publicly and stakeholders, particularly in the analytical community, have access to new developments which can help them in their statutory work and hence prevent referrals to the Government Chemist. However, these cannot predict every possible referee case, and method development is still necessary on an *ad hoc* basis.

► **See Section 3 for an overview of R&D activities.**

Advisory function

LGC, the current home of the Government Chemist function, can trace its origins back to 1842 when the Laboratory of the Board of Excise was founded in the City of London to regulate the adulteration of tobacco which was prohibited under the Pure Tobacco Act.

Work to protect Government Revenue continued to be the Board's main occupation until 1875 when the laboratory was appointed 'referee analyst' under the new Sale of Food and Drugs Act. This was a landmark in legislation as it was specifically designed to protect the consumer rather than the Revenue by ensuring, for example, that milk had not been watered down. The laboratory continued to develop after this time to become established for nearly half the 20th century as a free-standing central department, with a broad responsibility for the investigation and analysis of a wide range of samples and problems on behalf of other government departments and authorities.

On privatisation in 1996, LGC signed an agreement with the Secretary of State for Trade and Industry which underpinned the continuity of the broader public functions by appointing the Government Chemist 'as a source of advice for HM Government and the wider analytical community on the analytical chemistry implications on matters of policy and of standards and of regulations'. This agreement continues to this day and serves to highlight the importance of chemical and bio-measurements in underpinning the UK economy. As new technologies are developed and become more widely and routinely used, the need for such advice to be given adequately is even greater.

The principal means of delivery of the advisory function is in the response to government calls for advice or published consultations, where there is a significant or important analytical science content. These responses provide relevant information specifically to the department, agency, European Commission Directorate-General or other public body publishing the consultation, as well as to a broad range of stakeholders who have an interest in regulatory compliance and the associated measurement aspects. Consultation responses are published on the Government Chemist website[2]. The advisory function also looks at emerging issues involving new, updated or planned regulation and related analytical measurements and addresses these by means of small targeted projects and publications also published on the Government Chemist website.

► **See Section 3 for more about the wider advisory function.**

Governance

BEIS funds the Government Chemist programme to enable delivery of statutory casework, scientific advice and any research and development work necessary for the ongoing effectiveness of the Government Chemist's functions. Within BEIS, responsibility for both the Government Chemist and the wider UK National Measurement System lies with the International, Science and Innovation Directorate.

BEIS have put into place arrangements to ensure that the Government Chemist programme is delivered competently, and that scientific standards, impartiality, transparency and integrity are maintained. LGC has rigorous internal structures and procedures in place to ensure no conflicts of interest arise between work carried out under the statutory function and its commercial activities.

The GCPEG plays a key role in the governance of the Government Chemist programme, providing the necessary independent scrutiny of the programme. The GCPEG also offers advice to BEIS regarding future priorities, which feeds into the programme strategy and formulation process. It meets twice a year to oversee and discuss the delivery, planning and quality of the programme, and also has

[2] https://www.gov.uk/governmentchemist

oversight of the scientific standards of the programme. The GCPEG is tasked by BEIS to advise on:

- The effectiveness and impact of the programme in providing an independent, expert service to resolve disputes between food control authorities and food traders on analytical results and their interpretation;
- The progress of the current projects in meeting technical milestones and targets;
- The formulation and prioritisation of new projects to maintain and develop the capabilities needed to discharge the Government Chemist functions (i.e. capability building, knowledge transfer, regulatory foresight and statutory analysis).

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

Details of the membership of the GCPEG are given below.

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, FERA 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 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. He leads 48 laboratory staff who test a range of samples including food, water, asbestos, consumer products and environmental samples. He also leads an Environmental Assessment team. He has had a varied career spanning a range of businesses and organisations including Royal Ordinance Factory, Scottish & Newcastle Breweries, and Medicines Testing Laboratory. He is currently a senior manager with The City of Edinburgh Council where he manages a portfolio of income generating assets.

Simon Branch

Simon joined RHM Technology as a Senior Analytical Chemist in 1990, where he progressed through a number of roles to become Head of Innovation and Improvement, before moving to the McCormick Corporation where he took responsibility for the Product and Process Development teams. In 2014, he moved to Goldenfry as Head of Innovation. During his career, 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 leads the Surveillance, Methods and Laboratory Policy Team at the Food Standards Agency and is responsible for the Agency's surveillance strategy, policy on UK national reference laboratories and official control laboratories. Andrew is an official UK delegate on numerous international committees and also acts as advisor to various UK committees.

Lucy Foster

Lucy began her career as a government scientist at the Ministry of Agriculture, Fisheries and Food in 1998. She joined the Food Standards Agency in 2000 before moving to Defra in 2009. Lucy has considerable 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. Lucy is currently on a career break and her position on the GCPEG is temporarily covered by Sophie Rollinson.

Sophie Rollinson

Sophie joined the GCPEG in 2016 deputising for Lucy Foster. Sophie is the Food Science lead in Defra's Food and Farming Directorate and manages the Department's Food Authenticity Research Programme. She has worked as a scientist in government since 2003 in the areas of food standards and labelling, and microbiological food safety at Defra and the Food Standards Agency.

Jonathan Griffin

Jonathan began his career as a graduate scientist at Kent County Council, where he carried out classical and instrumental analysis of foods, agricultural samples, water and consumer goods. He completed the MChemA in 2002 and became a Public Analyst. He continues to work as Public Analyst and Technical Manager for Kent Scientific Services. Jonathan became President of the Association of Public Analysts (APA) in 2015, representing them in discussions with central and local government bodies and chairing the Council of the Association.

Martin Hall

Martin is the Director of Science at Campden BRI and has overall responsibility for the departments of Chemistry and Biochemistry, Microbiology, Consumer & Sensory Science, and Statistics. Martin has 40 years' experience of a wide range of food-related subjects with specific interests in food safety and quality, authenticity and analytical techniques.

Declan Naughton

Declan joined the Inflammation Research Group at Barts and The London School of Medicine and Dentistry, where he spent 10 years before accepting posts at the University of Bath and the University of Brighton. He is currently Professor of Biomolecular Sciences at Kingston University London. His research interests span food safety, nutrition, natural products, performance enhancing drugs, inflammation, drug discovery and endocrinology. He is currently the Interim Associate Dean for Research for the Faculty of Science, Engineering and Computing.

David Pickering

David is the Trading Standards Manager for the Buckinghamshire and Surrey Trading Standards Service. David qualified as a Trading Standards Officer in 1989 and has been part of and managed teams dealing with food, animal feed and animal health throughout that time. He has been the Chartered Trading Standards Institute Lead Officer for food for over 16 year and represents the profession on numerous groups including the national Food Standards Focus group. He has a law degree and a Masters of Law (LLM) in European Law.

Roger Wood OBE

Roger, after being appointed as Chief Chemist at a Public Analyst and Consulting Chemist practice, moved to the then Ministry of Agriculture, Fisheries and Food and completed his MChemA, both in 1974. Roger is an experienced food analysis specialist, who recently retired from the Food Standards Agency. He has represented the UK at numerous EU methods of analysis and sampling working groups in the food and feed sectors over the past 35 years and has been Chair of a number of international food analysis working groups.

Kirsty Dawes

Kirsty is a specialist in imported food, working for Suffolk Coastal Port Health Authority, based at the Port of Felixstowe. Kirsty is an Environmental Health Practitioner with a BSc in Environmental Health, and one of the few non-chemists in the group.

David Ferguson

David spent the first half of his career with BP Research before operating as an independent consultant for clients in the industrial, public and charity sectors in the analytical chemistry arena. During this time he worked for government as the Independent Advisor for the Government Chemist Function. He is currently semi-retired and looks after the affairs of the RSC Analytical Chemistry Trust Fund.

John Figgins

John is a Technical Specialist for Food at BRC Global Standards and served the Government Chemist expert group for over eight years. John stepped down to ensure conflict of interest did not arise following LGC's acquisition of BRC Global Standards in late 2016. The Government Chemist team would like to thank John for his excellent contribution during his time as a member of the expert group.

The Government Chemist programme: today and tomorrow

At the time of producing this review, the current Government Chemist programme (2014-2017) was in its final months of completion. Excellent progress has been made since April 2014 and the programme is on track to deliver all objectives by March 2017. In 2016, there was a series of highlights with regards to referee case work, novel methods developed, programme dissemination and stakeholder engagement, which are covered elsewhere in this review.

During 2016, a new programme of work for the following three year period (2017-2020) was formulated. This involved a comprehensive horizon scanning and stakeholder consultation process which resulted in the revision of the Government Chemist Strategy document[3] and the production of a series of new project proposals. While the key strategic aims of the Government Chemist remained the same, the UK's exit from the European Union was identified as a new factor on the horizon that will likely affect enforcement, standards and regulatory compliance in the future.

The new programme was prioritised and approved by the GCPEG in December 2016 following consideration of the effects of political, social, economic, environmental, and legal changes as well as scientific advancements. Referee analysis lies at the centre of the programme once again and will be supported by a series of R&D projects to prepare the Government Chemist for the likely future demands as the Referee Analyst.

Projects to further develop our capabilities to ensure food safety and authenticity for allergens, GMOs and mycotoxins were prioritised. In particular, novel molecular methods including Next Generation Sequencing (NGS) will be evaluated and high accuracy digital PCR will be further developed and applied. We will continue to exploit cutting edge separation science and mass spectrometry technologies for the analysis of protein allergens and mycotoxins, building on current and previous programmes. Looking further into the future, new work will evaluate the accuracy and application of 'point of use' technologies to address the emerging concept of 'the consumer as analyst' and the use of rapid measurements generated outside a controlled laboratory environment.

The new programme will also accommodate additional stakeholder engagement which reflects the increased call for Government Chemist scientists to provide expert opinion and to lead or contribute to stakeholder led committees. This contribution is invaluable in disseminating the work of the Government Chemist programme. We seek to maintain this meaningful dialogue with stakeholders and regulators in areas which link measurement and regulation, as well as to achieve closer relationships with other government departments such as the Ministry of Defence and the Home Office. We look forward to the new programme starting in April 2017 and to updating stakeholders on our progress in future Government Chemist Reviews and through the usual dissemination channels.

People

LGC staff who directly support the Government Chemist function have clearly 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[4], 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.

The members of staff carrying out work under the Government Chemist's statutory function must continually demonstrate their competence through participation in an extensive variety of appropriate proficiency testing schemes and collaborative studies. The diverse nature of LGC's scientific activities therefore leads to a wide range of skills and specialisms being available in-house. Many of the staff involved in delivering the programme have also carried out research and development work, often involving international collaboration, which gives them the capability to contribute positively and efficiently to their work.

[3] https://www.gov.uk/government/publications/government-chemist-strategy-2017-2020
[4] All work is overseen by Michael Walker, a nominated officer holding the statutory MChemA qualification

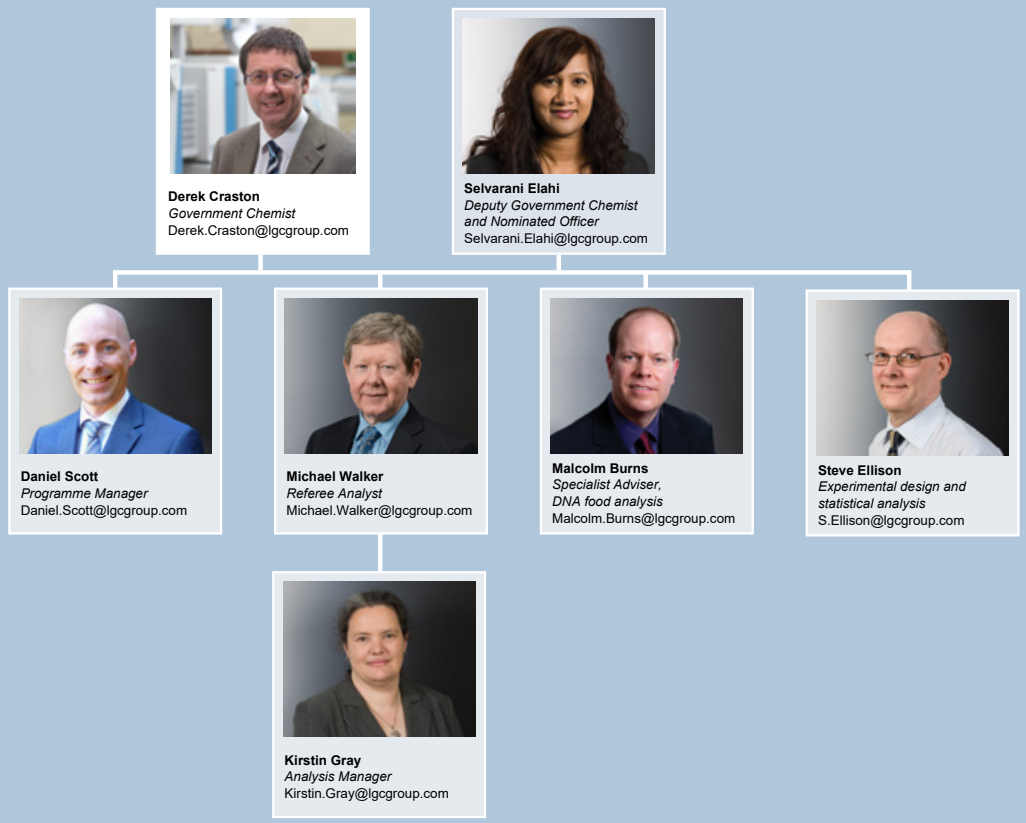
Collaboration

The Government Chemist's remit covers a very wide area of measurement science, which contains a significant number of potential challenges, not all of which can be predicted from our horizon scanning activities. Some of these challenges may lie outside our sphere of specific expertise, and the knowledge or equipment needed to address them may not be readily available within the broad range of activities undertaken at LGC. We are therefore alert to the possibility for collaboration with a range of potential stakeholders, who are able to complement our own expertise and activities, in order to ensure the Government Chemist function can be comprehensively discharged.

For example, during 2016 the Government Chemist team collaborated with the EU Framework Seven programme DECATHLON project by participating in a ring trial using Next Generation Sequencing (NGS) technology for food authenticity testing. This collaborative activity has already enhanced the Government Chemist's capability in understanding complex workflows in NGS applications, while ongoing work in meat and plant speciation analysis using DNA sequencing will improve our ability to respond to challenges in this area. We also have an ongoing collaboration with Manchester University in allergen research where we benefit from access to the latest developments in this very topical and complex area. Thus, our capability building research utilises a broad range of expertise which will benefit public health, safety and well-being, as well as the wider scientific community, including those UK manufacturing industries which depend on reliable and accurate analytical measurement.

For more information on our work, please contact us at government.chemist@lgcgroup.com or go to the website https://www.gov.uk/governmentchemist.

Figure 1 Government Chemist organogram and contact points



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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
Food Safety (Sampling and Qualifications) Regulations (Northern Ireland) 2013
Poultry Meat (Water Content) Regulations 1984
Natural Mineral Water, Spring Water and Bottled Drinking Water Regulations 2007[1]
Materials and Articles in Contact with Food Regulations 2012[1]
Agriculture Act 1970
The Animal Feed (Hygiene, Sampling etc. and Enforcement) (England) Regulations 2015[1]
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

2 UNDERPINNING SCIENCE

Referee casework arises most frequently under the Food Safety Act 1990 or the Agriculture Act 1970. During 2016, eight cases were referred to the Government Chemist – seven in connection with food and one in connection with animal feed. Table 1 gives further information about the provenance and the basis of the referee cases. In addition, work continued on several cases referred in 2015. Most of the problems referred to us in 2016 were familiar – mycotoxin contaminants and food additives. Surprisingly, the most challenging investigation involved the determination of low concentration levels of sulphites in the presence of foods such as garlic which gave rise to interferences.

Table 1 Overview of referee cases in 2016

Origin			Basis		
Inland Authority	2	25 %	Dispute	6	75 %
Port Health Authority	6	75 %	Other*	2	25 %

***Other includes SEO – Supplementary Expert Opinion, pursuant to Article 11(5) of Regulation 882/2004 on official controls, and requests for assistance from other government departments or local authorities.**

The referee function

Referee casework is a demand led service which has been at the core of the Government Chemist's function since 1875. Demand reduced in 2016 (see Figure 2) but maintained interest and complexity. Overall, casework numbers in the current 2014-2017 programme is similar to previous programmes.

In guaranteeing fair scientific treatment for all by authoritative adjudication on disputes we underpin public and industry confidence in the food and feed official control system. We maintain the even-handed credibility of this referee role by stringent governance of the function and painstaking analytical rigour. Our aim is to safeguard consumers, regulators, the agrifood sector and the courts from unwitting errors in measurement science.

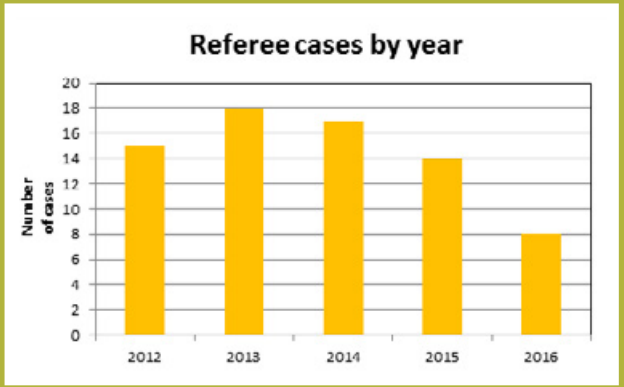


Figure 2 Referee cases by year

There is no legal definition of the referee analyst function. We regard it as independent expert analysis, including interpretation if necessary, to help avoid or resolve disputes. There are statutory provisions for referral of retained portions of formal[5] samples to the Government Chemist in regulations made under both the Food Safety Act 1990 and the Agriculture Act 1970[6].

Referee casework arises by a variety of routes, which usually begin with the contemplation or commencement of legal proceedings

[5] Formal samples taken under statutory enforcement provisions are divided into parts for analysis on behalf of the authorities, the food or feed business operator (FBO) and, when required, the Government Chemist

[6] Boley N., 2016, Annual statement of statutory scope, available at https://www.gov.uk/government/publications/government-chemist-annual-statement-of-statutory-scope-2015--2

where the prosecution intends to offer analytical evidence. The referral may be by the local authority authorised sampling officer, the prosecutor or the court. The defendant may also, subject to agreement to meet some or all of the Government Chemist's costs, request referral. If the above route is not open to a trader, they may request a supplementary expert opinion (SEO) pursuant to Article 11(5) of Regulation 882/2004 on official controls and in defined circumstances a SEO may be requested of the Government Chemist.

The Government Chemist also acts as a source of advice for government and the wider analytical community on the analytical chemical implications on matters of policy, standards and regulations. In some instances we are asked to resolve a dispute when a formal sample has not been taken. We deal with these instances on a case by case basis, either accepting a portion of the original informal sample or offering to comment on any apparently conflicting analytical results from the informal sample and other relevant data. However where it seems best to do so, we advise a further formal sampling exercise which ensures all parties receive properly sampled and divided parts of the same batch of food or feed.

Analytical results must be interpreted in increasingly complex scientific legal and policy contexts, and in an increasingly global supply chain. While our thorough approach to discharging the referee function has been consistently applied for many years, we have been steadily adopting forensic methodologies to deal with the progressive complexity. When a referral is received we begin with a case meeting to examine the problems associated with the case and often instigate a literature review of the topic. Few referee cases are routine nowadays and often our analytical methods must be newly devised or modified to deal with particular problems.

Our default analytical strategy is multi-replicate analyses on multiple days. The extent of replication together with analysis of reference materials, (certified, where available), and of blanks and spiked blanks and/or sample aliquots, practically amounts to a stand-alone method validation and provides the necessary high level of analytical confidence. All significant analytical steps are witnessed by a second scientist, all data transcriptions are checked and the results are evaluated against prescribed quality criteria. 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 (or his deputy) for peer review. If all steps are satisfactory the Government Chemist (or deputy) will allow the findings to be released.

During 2016 the Government Chemist completed work on dispute cases concerning very familiar causes such as mycotoxins, food additives and authenticity claims.

Mycotoxins

Mycotoxins, secondary metabolites produced by fungi, are naturally occurring toxic and often carcinogenic compounds found in food and feed. Hence, stringent controls are in place to reduce human consumption. 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. In 2016 we looked at aflatoxins in melon seeds[7] and in peanuts sold as wild bird feed, and at ochratoxin A in ground black pepper.

Aflatoxins, mainly produced by the moulds *Aspergillus flavus* and *Aspergillus parasiticus*, are genotoxic carcinogens capable of inducing liver cancer – particularly with simultaneous hepatitis B virus infection – and are among the most potent mutagens known. Avian species are particularly susceptible to acute toxicity from these compounds. Ochratoxins are also metabolites of fungal genera such as *Aspergillus* and *Penicillium*. Ochratoxin A (OTA), discovered in 1965 from *Aspergillus ochraceus* is, of the ochratoxins, the major metabolite of toxicological significance. It occurs mainly as a contaminant of cereal grains although it has also been found in beans (soya beans, coffee, cocoa), peanuts and meat. OTA gives rise to characteristic renal pathologies, is teratogenic in animal models and is an inhibitor of hepatic mitochondrial transport causing damage to the liver, gut, and lymphoid tissue[8].

For both the aflatoxin cases we upheld the Public Analysts' findings and the consignments were prevented from entering the UK food chain. In the case of OTA in ground black pepper our results supported those of the trader's laboratory. The scatter between laboratories and discussion with the Public Analyst revealed the sample had been difficult to homogenise before division into three, a more likely reason for the divergent results than any within-laboratory error. Homogenisation by high sheer aqueous mixing has been shown to be effective for aflatoxin analysis[9] but no similar guidance is available for contaminants in spices.

[7] Submitted as agushi and also known as agusi or egusi

[8] Walker M. and Wong Y.-C., Protection of the agri-food chain by chemical analysis: The European context. In Bhat R. and Gomez-Lopez V. M. (Eds) Practical food safety: Contemporary issues and future directions, 2014, Wiley-Blackwell, ISBN 978-1-118-47460-0, p 129-132

[9] Walker et al., Aflatoxins in groundnuts – Assessment of the effectiveness of EU sampling and UK enforcement sample preparation procedures, J Assoc. Public Anal., 2017, 45, 1-21

Food authenticity

Food authenticity – food sold which is of the nature, substance or quality demanded by the purchaser and accurately matches its description or labelling – is important to consumers, industry and regulators. Misdescription or mislabelling of food is illegal, potentially harmful, penalises the honest trader, and undermines consumer choice and value for money. When driven by financial gain it is 'food fraud' and when it results in serious harm or involves organised criminals it is 'food crime'. Authenticity is primarily determined by documentation, traceability and audit, although this can be difficult and time consuming especially with imported food. In many instances verification of the composition, origin and processing of food can only be accomplished by analytical means. This is, however, often challenging and has harnessed state-of-the-art methods in genomics, metabolomics, spectroscopic and stable isotopic and trace element measurement to achieve its aim.

Food authenticity has been a constant feature of Government Chemist work from the inception of the function, and in 2016 we were asked to look into the authenticity of honey. Honey is globally defined by a *Codex Alimentarius* standard[10] and in European law[11]. Although mainly composed of the sugars fructose and glucose, and water, honey contains a complex range of other sugars, amino acids, proteins, organic acids, vitamins, minerals, enzymes, polyphenols, other trace compounds, and of course, pollen. The botanical source, geographic origin and description of honey are important trade and consumer attributes for which no single analytical method can be definitive. Rather, an ever widening range of approaches, which recently have included NMR, are required analytically to verify claimed attributes.

In one honey case referred to us, the Trading Standards officer was ultimately satisfied as to the traceability of the product in question and the case was withdrawn. Recognising the work on honey authenticity underway at other institutions, e.g. the Joint Research Centre (JRC)

[10] CODEX STAN 12-1981, Honey, revised 1987 and 2001

[11] Council Directive 2001/110/EC relating to honey, implemented by the Honey Regulations 2015 in each country of the UK

Geel, and by the New Zealand authorities we paused in our deliberations on a second honey enquiry to await these outcomes. We will resume active work in this area in 2017.

Allergens

Food allergy is a major public health concern with high costs to public health services. There are well-documented detriments to the quality of life for allergic consumers and their families, and about ten food-related anaphylaxis deaths (and potentially more near misses) every year in the UK. There are also a significant number of food allergen-related incidents and food recalls with a concomitant impact on food businesses. Many consider that the introduction of thresholds or action levels for food allergen risk management will deliver improvements for all stakeholders. However published thresholds remain to be generally accepted and are impossible to police adequately because of deficiencies in analytical methods for allergens. During 2016 we made substantial contributions in this area – our paper on potentially flawed allergen analysis[12] was one of the 25 most downloaded papers of 2016 in the premier RSC journal *Analyst*. Our work on methods for allergen analysis in spices was also well received [see section 3, Impact, for articles on spice analysis and protein quantification].

We also focused on the only non-protein allergen group, the sulphites, for which disclosure is required if present in food to protect consumers vulnerable to its effects.

Sulphites

The generic term 'sulphites' describes a range of permitted food additives that consist of or generate sulphur dioxide, SO_2, the active compound, in food. Analytically sulphites are generally determined as sulphur dioxide, and depending on pH, a series of equilibria exist, Figure 3.

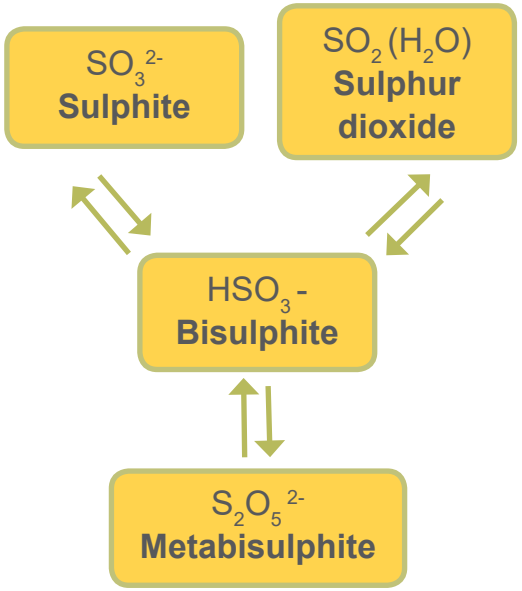


Figure 3 Sulphite equilibria in food[13]

Sulphites are a very useful group of additives with antioxidant and antimicrobial properties. They inhibit a wide range of browning reactions in food and are widely used in the food industry to preserve food quality and appearance[14]. They occur naturally in both the human body and in food and are also produced by some microorganisms. As with any food additives, sulphites have been evaluated for their possible toxicity and assigned an acceptable daily intake (ADI). However, the ADI was based on data gathered some time ago so it was reviewed[15] by the European Food Safety Authority (EFSA), in 2016. EFSA noted that although adequate, the ADI should be considered temporary while available information is improved. Recognising this limitation, the ubiquity of use of sulphite additives, their destruction of thiamine and other vitamins and the potential to disguise decay in food, the use of sulphites is confined to foods in a permitted list. Where permitted, the concentration must remain below maximum permitted limits.

Additionally, during the 1980s, reports emerged implicating sulphites as initiators of asthmatic reactions in small subsets of the asthmatic and non-asthmatic populations. Ingestion of foods containing sulphites was alleged to have caused fatalities. Numerous reports of sensitivity or intolerance reactions in humans exposed to sulphited solid foods and beverages led to sulphites being included in the list of major allergens controlled by the Food Information Regulation, (Article 21 and Annex II of Regulation 1169/2011). This measure requires labelling of added substances listed in Annex II which cause allergies or intolerances, either in the list of ingredients of pre-packed foods where the entry must be emphasised through a typeset that clearly distinguishes it from the rest of the list, or disclosed orally to customers in non-prepacked sales. Interestingly, of the Annex II allergens, sulphites is the only one for which there is a legal threshold – the Annex applies only to products containing more than 10 mg kg^{-1} sulphites as SO_2, the limit of detection of the Monier-Williams method for SO_2.

[12] Walker M. J., Burns D. T., Elliott C. T., Gowland M. H., Clare Mills E. N., Is food allergen analysis flawed? Health and supply chain risks and a proposed framework to address urgent analytical needs, Analyst, 2016, 141, 24-35

[13] Fazio T. and Warner C. R., A review of sulphites in foods: analytical methodology and reported findings, Food Addit. Contam., 1990, 7(4), 433-454

[14] Wedzicha B. L., Chemistry of sulphiting agents in food, Food Addit. Contam., 1992, 9(5), 449-459

[15] EFSA Panel on Food Additives and Nutrient Sources Added to Food (ANS), Scientific Opinion on the re-evaluation sulfur dioxide (E 220), sodium sulfite (E 221), sodium bisulfite (E 222), sodium metabisulfite (E 223), potassium metabisulfite (E 224), calcium sulfite (E 226), calcium bisulfite (E 227) and potassium bisulfite (E 228) as food additives. EFSA Journal, 2016, 14(4), 4438. Available online: www.efsa.europa.eu/efsajournal and announced 14 April 2016 http://www.efsa.europa.eu/en/efsajournal/pub/4438

Analysis for sulphites in food is often relatively straightforward and many methods have been published. Reference methods are variations of the Monier-Williams procedure first published in 1927. In this method, acidification of the sample dispersed in water in a multiple necked reaction flask drives the sulphite equilibrium to sulphurous acid. Gaseous SO_2 is entrained in nitrogen gas bubbled through the boiling liquid under reflux conditions. The SO_2 is trapped in neutralised hydrogen peroxide, forming sulphuric acid which is determined volumetrically against standardised sodium hydroxide solution.

However the Monier-Williams method has long been known to be interfered with positively by foods such as dried garlic and soya proteins, and to a lesser extent by onions and cabbage. These interferences are caused by the presence of volatile sulphur-containing compounds. For example the aroma and taste of garlic owe much to a compound known as allicin (a thiosulphinate). When fresh garlic is chopped or crushed, the enzyme alliinase converts a precursor compound, alliin (S-allyl-cysteine sulphoxide) into allicin. Alliin and alliinase are separated in different cell compartments in garlic, including dried garlic, and the reaction only occurs when the garlic is crushed or the dried garlic is wetted. The allicin generated quickly decomposes into a series of other sulphur-containing compounds such as diallyl disulphide.

Called upon to look into the possible undisclosed addition of sulphites close to the cut-off concentration of 10 mg kg^{-1} to a niche product containing several of the known interfering foods, we applied a range of techniques to the problem. After a lengthy and challenging investigation we found that only LC-MS/MS methods, owing to both chromatographic separation and mass spectrometric identification, gave sufficient confidence to the results. Even so, investigations continue to develop a method that will achieve the ultimate rigour to be desired in a referee analysis.

Conclusions

The year under review has once again provided interesting and varied referee casework. By the use of sophisticated equipment, a high analytical replication rate, contextual and forensic awareness of analysis and interpretation we aim to offer consumers, industry, the courts and regulators assurance that the technical appellate function is discharged to the highest possible standards. Inevitably, these measures require considerably more time and resource than routine testing, but they do however safeguard stakeholders from potentially very costly errors.

We disseminate our learning from referee work via speaking engagements, our biennial conference, publications in recognised journals and online outlets. Hence it is a pleasure to acknowledge the assistance of colleagues in LGC and co-authors, principally Professor Duncan Thorburn Burns, who has given generously of his time and expertise in drafting the outcomes of our work for peer reviewed publication, a key measure of transparency in the discharge of the Government Chemist's responsibilities. We are also grateful to Norman Michie MChemA, editor of the Journal of the Association of Public Analysts[16], for his kind assistance in publishing several other articles as open access publications for the benefit of the entire analytical and regulatory community.

[16] http://www.apajournal.org.uk./index.html

3 IMPACT

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

We carry out horizon scanning activities to identify the areas where referee cases are more likely to arise, or where new regulation/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 research projects to support those identified areas.

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

We disseminate our project outputs through knowledge transfer activities and publications (both of which are detailed later in this review). The advisory function of the Government Chemist provides advice on a breadth of analytical measurement subjects within a regulatory and legislative context, to government, the European Commission, and the wider stakeholder community.

All these activities are aimed at translating current capabilities into timely support and advice, and predicting future regulatory issues within the areas of chemical and biochemical measurements with the objective of providing a secure base for more efficient and cost-effective regulations.

Horizon scanning

As a demand led service we carry out regular horizon scanning to prepare for problems and update our contextual awareness. From time to time, it is appropriate to look further ahead to attempt to anticipate how the Government Chemist programme might be required to adapt to future needs.

Hence, in 2016 a far horizon scanning exercise was undertaken in collaboration with the GCPEG. The exercise was based on the Shell generic seven questions for the future – a technique developed by Shell for internal strategy reviews. These questions allowed us to consider, with our stakeholders, the aspirations

for the relationship between the measurement science community and wider society over an approximately 20 year horizon span. Such projection can be admittedly problematic, but the aim was to identify in some detail the sort of adjustments which might be required in the Government Chemist programme in the medium-term so it can deliver against longer-term changes.

The questions that were asked of stakeholders were:

1. **The future:** Thinking over a time horizon of 10-15 years, if you could spend some time with someone who knew the future, a clairvoyant or oracle if such existed, what would you want to know and what are the critical issues concerning:

   a. Measurement science
   b. The relationship between the measurement science community and wider society
   c. How regulation of food and feed will reflect this relationship
   d. The impact this will have on the Government Chemist

2. **An optimistic but realistic outcome:** If things went well, how would you expect the Government Chemist function to develop and what would be the signs of success?

3. **A pessimistic outcome:** How could the environment change to threaten the Government Chemist function? How could our service deteriorate?

4. **Looking forward:** What decisions need to be made in the near-term to achieve the desired long-term outcome for the Government Chemist function?

5. **The open mandate:** If you had a mandate, free of all constraints, what more would you do to ensure a successful future for the Government Chemist function?

The key themes that emerged were:

- Regulation must allow confidence for the consumer and the wider society. If there is no confidence then there will be more challenges of results which the Government Chemist will need to cope with.

- Although the stakeholder consultation was carried out prior to the vote on leaving the European Union, stakeholders were alive to the possible ramifications which could include more demand on the Government Chemist as a result of a less harmonised approach across the European trading bloc.

- In the longer term, advances in biological sciences will see a shift from 'chemicals' to 'biologicals' in the food and farming sector, as synthetic biology offers the possibility of new pesticide routes for gene suppression and RNA inhibition.

- The consumer could become the analyst using hand held devices for example to check composition, nutrition and allergens – with a need for the Government Chemist to understand the capabilities, and for proper calibration of point of use devices.

- Precision agriculture developed further with artificial intelligence becoming prevalent. In addition, alternative food sources such as insects and artificial meat are predicted to become more common. We may also see the introduction of intelligent and even possibly edible packing.

- Rapid advancement of synthetic biology and potentially cloning. In the longer term, there is also a perception that omics and fingerprinting approaches will become more commonplace and should also therefore be taken into consideration.

Novel and unexpected measurement challenges were the raison d'être for the Government Chemist in the 19th century. In the 21st century, the Government Chemist is still required as a backstop against measurement or interpretative error and the challenges continue to be wide and varied. As a result of our far horizon scanning exercise, we are prioritising in the next Government Chemist programme (2017-2020) capability building research into point of use devices and novel molecular biology systems.

Development and dissemination of analytical approaches for herbs and spices testing

As well as further developing cutting edge applications for herbs and spices testing, during 2016 the Government Chemist function continued to disseminate best practice measurement advice and guidance associated with this topical area, culminating in the publication of two peer reviewed papers in an international journal[17,18]. The first paper described a real-time PCR approach for the specific detection of *Prunus mahaleb* using a fluorescent-based probe system. The second publication provides details on a more general real-time PCR approach followed by melt curve analysis to help identify species within the *Prunus genus* (such as almond, mahaleb, apricot, peach, etc.).

Background referee cases

Food allergies represent a definite threat to the general health and well-being of those affected, placing increasing pressure on food producers and regulatory authorities to test for their presence. Reports in recent years on fraudulent food activity include adulteration of herbs and spices with nut material. Such activity can prove an immediate health risk to individuals allergic to specific nut species. In 2015 a number of food products containing cumin were subject to withdrawal from the international market because of alleged adulteration with peanut and almond material. However, unequivocal identification of the actual adulterant proved difficult using the state-of-the-art of the science, mainly because of cross-reactivity issues associated with a number of the traditional analytical approaches used for detection of allergens and nut material.

In 2015, two samples of herbs and spices were referred to the Government Chemist for analysis in order to identify the potential presence of nut material. Alongside the application of ELISA and mass spectrometry, molecular biology approaches using DNA as a target analyte were shown to be fundamental in the correct identification of nut species present in these samples. The application of a novel real-time PCR assay for the detection of a specific nut species, as well as the development of a more general 'melt curve' analysis approach for the identification of a range of nut species, were undertaken within the Government Chemist programme. The DNA approaches which were developed showed that they were both sensitive and specific, had a multi-analyte capability, and provided demonstrable evidence that the approaches could be used to detect DNA from a specific allergen.

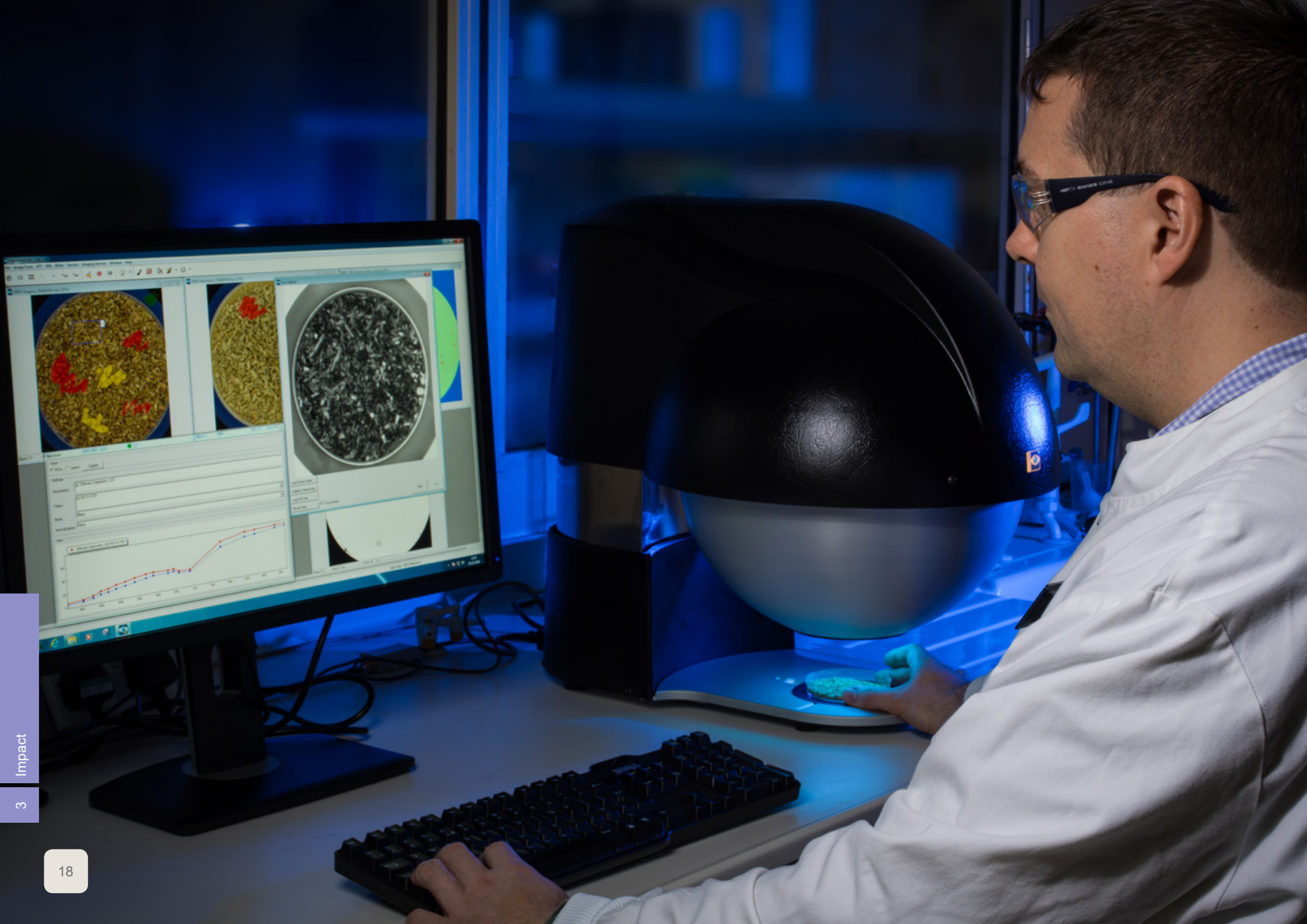
While the referee casework took place in 2015, the Government Chemist team undertook knowledge transfer and dissemination activities during 2016 for the benefit of stakeholders in the food testing sector.

Published papers

In our first paper on this topic we describe the development of a novel real-time PCR assay for the specific detection of *Prunus mahaleb*, a species known to be capable of causing false positives in almond immunoassays. The assay was developed based on available DNA sequence information from the Internal Transcribed Spacer (ITS) region, and tested against representative species within the *Prunus* genus to ensure no cross-reactivity. This real-time PCR assay was successfully developed and used in the Government Chemist programme in 2015 to identify the presence of mahaleb DNA in a cumin spice product that was subject to an international recall, which could not be unequivocally identified using immunoassay approaches alone.

In work described in our second paper, a commercial paprika sample suspected of having been adulterated with almond was analysed using a novel real-time PCR approach utilising DNA melt analyses. The developed method provided analysts with a simple and broad molecular tool to supplement non-specific ELISA *Prunus*-positive findings in order to identify common *Prunus* species for food authenticity and allergen testing purposes.

[17] Burns M., Walker M., Wilkes T., Hall L., Gray K., Nixon G., Development of a real-time PCR approach for the specific detection of *Prunus mahaleb*, Food Nutr. Sci., 2016, 7, 703-710
[18] Nixon G., Hall L., Wilkes T., Walker M., Burns M., Novel approach to the rapid differentiation of common Prunus allergen species by PCR product melt analysis, Food Nutr. Sci., 2016, 7, 920-926



Presentations

In May 2016, Dr Malcolm Burns attended the 'Tackling food fraud' event held at Campden BRI. The meeting was attended by around 100 participants, representing food analysts, laboratory technicians, technical managers, retailers and the food service, and provided an opportunity to learn and exchange ideas on topical food fraud issues. Malcolm gave a presentation on the DNA analysis of herbs and spices samples that had been adulterated with nut material, as well as applications of multispectral imaging in this topical area. This presentation summarised how the Molecular Biology Group at LGC used a range of modern analytical laboratory instrumentation and approaches to investigate the potential adulteration of cumin and paprika samples with nut material derived from the *Prunus* genus (including almond and *Prunus mahaleb*). The presentation also focused on the use of the new and emerging technology of multispectral imaging and its application in testing for the adulteration of herbs and spices, amongst other products. Malcolm also gave an invited presentation on the same topics at the technical meeting of the Seasoning and Spices Association (SSA) in October, held at the Food and Drink Federation (FDF) in London.

The pioneering work carried out by molecular biologists in the Government Chemist programme was further highlighted in the 5th report by the FSA's Chief Scientific Advisor, Professor Guy Poppy, on Food Allergy and Intolerance.

The Government Chemist was invited to contribute to the Grain and Feed Trade Association (GAFTA) publication. Based on the recent work on DNA approaches for herbs and spices testing, Malcolm Burns contributed an article released in the November edition of GaftaWorld[19], which covered the Government Chemist's leading research in developing and validating methods and approaches for food authenticity, adulteration, quality and safety testing.

The Government Chemist continues to push forward with the application of cutting edge analytical technologies for food authenticity testing, inclusive of applications for herbs and spices testing. Publication of the the two peer reviewed papers, as well as the dissemination of the work at scientific and public forums, helps provide best measurement practice advice for analytical laboratories involved in trace detection of ingredients in support of relevant food labelling legislation.

Recovery of protein allergens from processed food for immunoassay and mass spectrometry analysis – A real problem for quantification

Food allergies are estimated to affect 5% of adults and up to 8% of children, with prevalence rising year on year. There are no well-established treatments for food allergies and strict avoidance of sensitised foods is the only management strategy available to sufferers. Avoidance of ubiquitous food ingredients such as milk, egg and peanuts is, however, difficult. Indeed there were an estimated 18,471 hospital admissions due to allergies in England in 2011/12 alone. In a large number of countries, the eight most common food allergens, which include milk, egg, peanut and soy, must be labelled if used as a food ingredient. It is, however, the contamination of unlabelled foods with allergens that poses a serious problem to allergic consumers.

Despite extensive European regulations there are no official threshold limits for labelling requirements, which are instead defined by the presence or absence of an allergen. This has led to the popularisation of precautionary labelling, a practise which not only reduces consumer choice but can also desensitise them to cautionary labelling. Work is currently underway on trying to define suitable thresholds and reference doses but current proposed limits have not been unilaterally agreed upon.

[19] Burns M., New approaches for herbs and spices testing, Gaftaworld newsletter, Issue 223, December 2016 http://www.gafta.com/write/MediaUploads/Gaftaworld/December_2016.pdf

Current analytical position in allergen detection

A key component to defining and enforcing allergen thresholds is their accurate quantification in processed foods. Although a range of detection methods exist, immunoassay and mass spectrometry (MS)-based methods are analytically preferred due to the ability to detect the presence of specific proteins at low levels. Enzyme-linked immunosorbent assays (ELISAs), which rely upon the use of antibodies that are raised to be specific to the protein of interest are most commonly used for allergen detection. Importantly, one the most significant factors determining an immunoassay's specificity is how the antibodies used in an ELISA assay have been produced, i.e. the type of epitope to which they react. For this reason the antibodies used in such assays have been shown to be one of the largest contributing factors to measurement variability. Results derived from ELISAs are further complicated in food analysis by the possible effects that food processing may have on an allergen's structure and therefore an antibody's recognition of epitopes[20].

Recently it has been demonstrated that the use of mass spectrometry-based methods in food allergen analysis has the potential to provide higher specificity than current immunoassays[21,22]. Here, protein detection is not reliant on a protein epitope but instead on the identification of highly specific 'surrogate peptides' following the proteolytic digestion of extracted proteins. The inclusion of isotopically labelled internal standards (IS) in such methods can provide the sensitivity, specificity and traceability required for the development of reference methods.

Despite the advantages of mass spectrometry, the accuracy, precision and sensitivity of a quantitative method is reliant on the efficient and reproducible extraction of the protein(s) of interest (a trait common to ELISA methods). Protein extraction has been found to be particularly challenging in processed foods, where thermal processing can trigger a wide range of chemical reactions which have the ability to modulate protein structure, cause chemical modifications and, importantly, influence protein solubility. As such, it is necessary to be able to properly assess the suitability of current allergen extraction methods prior to the development of quantitative methods that can effectively underpin current legislation and risk management protocols. There are a number of published allergen extraction methods that claim to provide high recoveries, however, without certified reference materials (CRM) for allergens in food matrices calculating reliable and comparable allergen recoveries is not possible.

Towards food allergen reference materials

Proof-of-principle experiments have been performed that demonstrate the ability to calculate food allergen recovery rates from processed foods through the use of a prototype reference material. The prototype was subsequently used to develop a novel MS-compatible extraction method for incurred alpha casein in biscuit. This method was found to provide higher recovery rates than those currently used in food analysis and its efficacy has subsequently been applied to the extraction of allergens from food spices.

In order to facilitate the development of a prototype reference material, a mass spectrometry-based quantification method that provides results traceable to the International System of Units (SI) was developed for an aqueous solution of alpha casein, a major allergenic component of cow's milk. Three alpha casein tryptic peptides were selected for quantification based primarily on the specificity they provided the method. A digestion method was subsequently developed that achieved the complete release of all three monitored peptides from their parent protein. Quantification of the aqueous alpha casein solution was achieved with the use of isotopically labelled peptide standards and isotope dilution mass spectrometry (IDMS). IDMS results show a good quantitative agreement between two of the three peptides monitored (T3 and T11, see Figure 4) confirming completeness of the digestion and applicability of the method for SI traceable quantification.

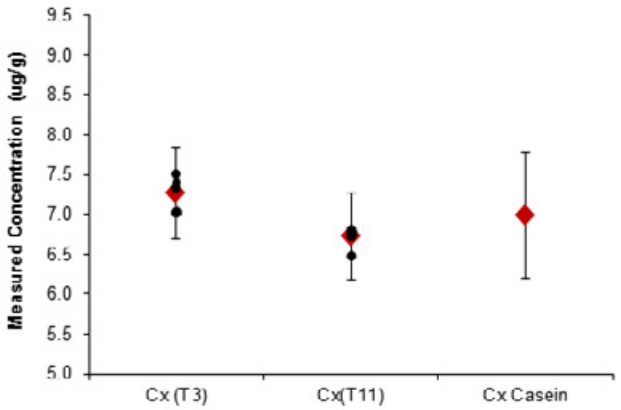


Figure 4 Results of the IDMS quantification of an aqueous solution of the milk allergen α-S1 casein. Black circles denote quantification results for repeat sample analysis while red diamonds are mean results across the five replicates. Cx Casein data represents combined results from the two peptides. Error bars represent the expanded measurement uncertainty of each individual concentration calculation (k = 2) at the 95% level of confidence.

For the comparison of recoveries between extraction methods, the quantified alpha casein stock solution was spiked, prior to cooking, into in-house baked biscuits at a concentration of 60 mg kg^{-1}. The biscuits were used to evaluate the recovery of casein from solid matrices by i) a published extraction method (Ansari et al.)[23] previously used for the MS-based analysis of milk allergens and ii) an in-house developed MS-compatible extraction method.

[20] Iqbal A., Ateeq N., Effect of processing on the detectability of peanut protein by ELISA, Food Chem., 2013, 141, 1651-1654

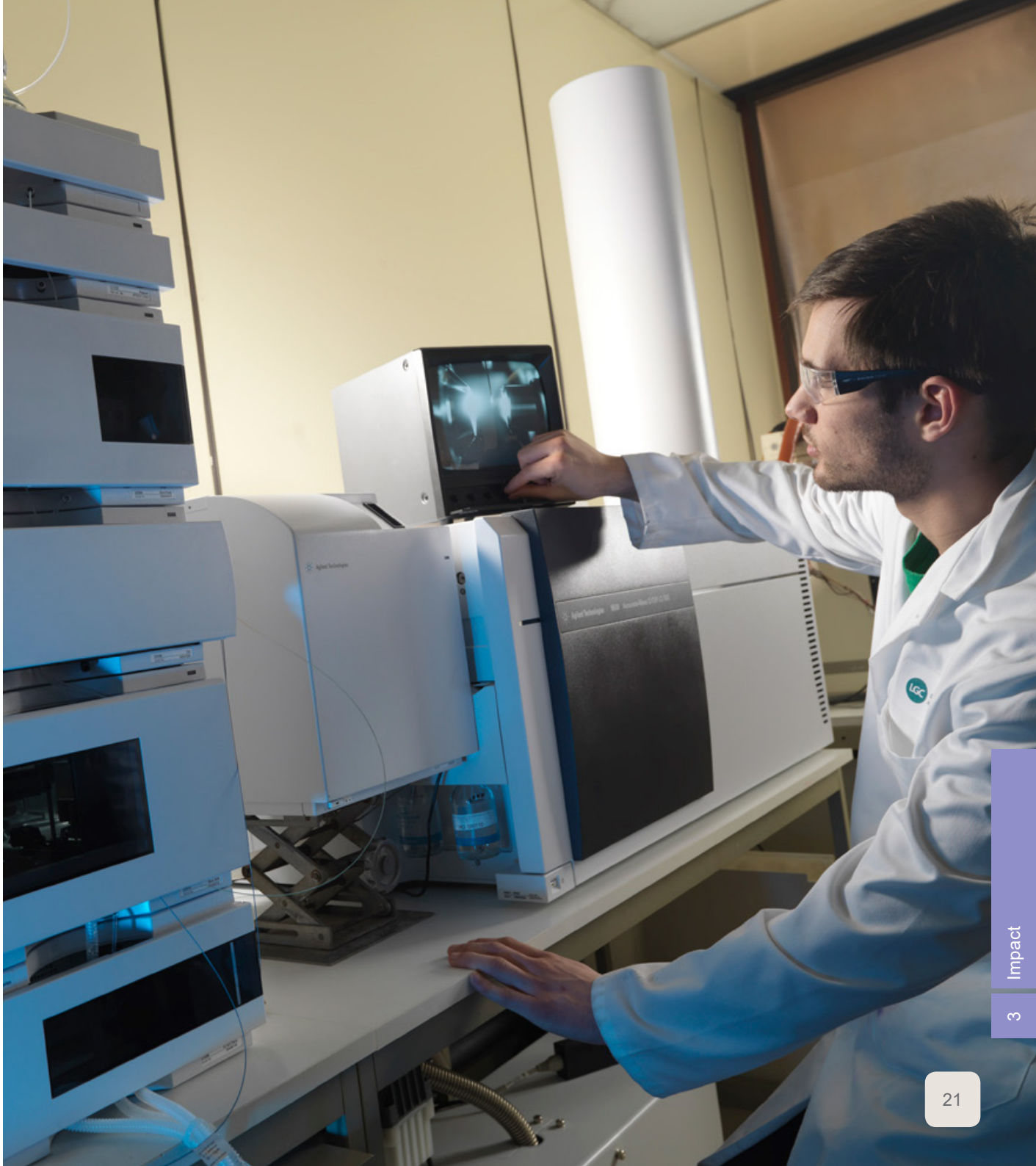
[21] Popping B., Godefroy S. B., Allergen detection by mass spectrometry-the new way forward, J AOAC Int., 2011, 94, 1005

[22] Cryar A., Pritchard C., Burkitt W., Walker M., O'Connor G., Burns, D. T., Quaglia M., Towards absolute quantification of allergenic proteins in food – Lysozyme in wine as a model system for metrologically traceable mass spectrometric methods and certified reference materials, J AOAC Int., 2013, 96, 1350-1361

[23] Ansari P., Stoppacher N., Rudolf J., Schuhmacher R., Baumgartner S., Selection of possible marker peptides for the detection of major ruminant milk proteins in food by liquid chromatography-tandem mass spectrometry, Anal. Bioanal. Chem., 2011, 399, 1105–1115

Results from the MS analysis found that the in-house method, which involves multiple cycles of heat extraction followed by tryptic digestion, provided at least double the recovery of alpha casein when compared with the Ansari et al. extraction method. Recovery rates were, however, still as low as 26%, despite the Ansari et al. extraction method claiming to have recovery rates higher than 50%. These experiments clearly highlight the current gap between calculated and actual allergen recovery rates, which could in part be bridged by the introduction of CRMs for allergens in common food matrices. Preliminary experiments comparing ELISA recovery rates with our in-house extraction method have found an even larger disparity, where the presence of food matrix was found to reduce recoveries in the three ELISA assays tested by close to an order of magnitude.

The results from this study prove the potential benefits of food allergen CRMs for ensuring food safety. In particular, to help support the development of accurate quantification methods, which rely on the ability to determine true extraction efficiencies from complex food matrices.



Knowledge transfer

The Government Chemist seeks to benefit innovation and regulation by dissemination of knowledge gained through our work, particularly in referee analysis. This dissemination is aimed at both the analytical and regulatory communities to improve knowledge and skills through a coherent package of knowledge transfer activity which includes:

- The organisation of the Government Chemist conference (on a biennial basis);
- The publication of case studies based on actual referee analysis;
- The organisation of training in collaboration with the APA Educational Trust, the Food Standards Agency (FSA) and Department for Environment, Food and Rural Affairs (Defra);
- Proactive input to key stakeholder organisations; and
- Provision of sound advice to stakeholders.

Government Chemist conference

The Government Chemist is not just responsible for resolving scientific disputes; we also have a duty to disseminate the knowledge gained through our research projects and work on referee cases. The biennial Government Chemist Conference is an important event in the programme calendar. The 2016 conference, held on 21-22 June at the Royal Society, attracted over 120 delegates from approximately 60 organisations.

The theme of the conference was 'science supporting trust in food'. The audience of public analysts, government officials, industry and public sector scientists, academics, instrument suppliers and leading food experts heard how measurement science has a fundamental role to play in ensuring the safety and authenticity of the food chain.

Derek Craston opened the conference, followed by a keynote presentation from the Government Chief Scientific Adviser (GCSA) and Head of the Government Office for Science, Sir Mark Walport. Sir Mark highlighted the findings of his second annual report 'Forensic science and beyond: authenticity, provenance and assurance'. He focused on some of the challenges in food authenticity control, such as how our ability to analyse may outstrip our ability to interpret; the need for appropriate reference databases and the impact that values and beliefs have on objective scientific analysis. He also discussed how modern technologies can be used to assure the supply chain including block-chain for assuring authenticity and provenance, and exploiting the microbiome to test claims about product origin.

Other presentations across the two days included a talk by Paul Turner, Imperial College London, on the challenges of managing food allergies in the real world. He discussed recent advances in allergy prevention and the use of desensitisation treatment and the clinical challenges associated with allergy diagnostics. The conference also featured presentations on the latest analytical techniques that can be used in support of food authenticity including rapid DNA sequencing methods, techniques for vegetable oil speciation in processed foods, and methods for the spirit drinks sector.

Recent Government Chemist referee cases were presented by Michael Walker, LGC, with further technical details on the analysis underpinning the cumin/paprika case presented by Gavin Nixon and Chris Hopley (both of LGC).

Delegates also heard presentations on the roles of some of the bodies responsible for ensuring food safety and authenticity and the challenges they face, including the Public Analyst Service, the UK Customs Laboratory, the Food Authenticity Network, the National Food Crime Unit and Food Standards Scotland (FSS). An international perspective on food safety was provided by Yiu-chung Wong from the Hong Kong Government Laboratory.

In addition to support from the Government Chemist programme, sponsorship was received from Defra, FSA, FSS and the APA Educational Trust.

A selection of the presentations from the conference is available at 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 2016, 44 articles including news and reports, were published on the Government Chemist webpages, which have been viewed in approximately 22000 unique visits. Articles about allergen management and the Government Chemist conference were amongst the most frequently accessed documents.

Advice

Many stakeholders turn to the Government Chemist for advice on a wide range of topics. We answer on average four requests for advice per month, a level that has remained constant for the past few years. Table 2 summarises who asked us for advice in 2016 and Table 3 describes the topics we were asked to comment on.

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

The enquirers were invariably grateful for our time and advice.

Origin of enquiry	Number of enquiries
Commercial	8
Official Control Laboratories	8
Press, radio, journals, etc	7
FSA/Defra	6
Trading Standards/ Environmental Health/Local Authority	4
Port Health Authorities	3
Government (international)	2
Individual	1
Coroner's office	1
Border force	1
Total	41

Table 2 Stakeholders asking the Government Chemist for advice in 2016

Subject	Number of enquiries
Manuscript review, articles, etc	6
Allergens	3
Authenticity/Identification	3
Jelly mini cups	3
Alcohol content	2
Aluminium in noodles	2
Pesticides	2
Referee analysis	2
Sample preparation/ aflatoxins	2
Other	16
Total	41

Table 3 Summary of topics we have advised on

Training

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

Summer school – analysis of food

In cooperation with the APA Educational Trust, our joint flagship training activity is the 'Analysis and Examination of Foods' – an intensive annual week-long residential postgraduate 'summer school'. This is held at Reading University and although aimed at Public Analyst laboratory staff is an opportunity for any analyst seeking to upskill in food and feed analysis. After a rigorous assessment process in 2016 the Royal Society of Chemistry (RSC), the professional body for chemical scientists, granted 'approved training course'[24] status to the course. We are grateful to RSC and in particular Dr Andrea McGhee, RSC Accreditation Development Specialist, for steering us through the assessment. The course, over a two year cycle, offers a distinctive learning experience, validated by active practitioners in the APA Training Committee, with unique features:

- A vibrant mix of lectures, laboratory practical sessions and interactive exercises;
- Wide range of experts, not available together elsewhere;
- Up-to-date teaching of safety (chemical and microbiological), authenticity, analysis and the law of food, water, feedingstuffs and fertilisers;
- Professional networking with peer group and leading experts, National Reference Laboratories, senior academic researchers and policy officials;
- Alignment with the MChemA syllabus, the statutory qualification required to practice as a Public Analyst;
- Practical and relevant training in microscopy and microbiology;
- Interactive exercises including 'expert witness' role play mentored by experienced court going scientists;
- Support in the form of delegate packs, pre-course material and information in the 'Training' section[25] of the APA website, which is regularly updated by the APA Training Committee.

In April 2016 we hosted 13 registered delegates. The delegates were from UK and Isle of Man Public Analyst Laboratories, both private and public sector. The course received excellent feedback and all delegates recorded that they enjoyed the course and considered that it met their expectations to a high degree. More information on the course is available on the Government Chemist website.

The Reading course was organised and facilitated by Michael Walker acting as APA Training Officer. Michael also organised a training seminar on health claims regulation, recorded several webinars for broadcast and in 2016 participated in the 'Romer Academy' two-day intensive workshop on allergen management and advanced testing in Austria.

Health claims training seminar

Regulation (EC) No 1924/2006 governs the use of nutrition and health claims in the labelling, presentation and advertising of foods. This complex and still evolving piece of legislation has many facets hence enforcement can be challenging. To address these challenges, a seminar was arranged by the Government Chemist programme to bring together stakeholders to share insights on the regulation (including self- and co- regulation), and enforcement of health claims on food labels and in adverts. The seminar took place on 29 September 2016 at the RSC, Burlington House, London with 51 attendees (including speakers) from across a wide spectrum of stakeholders, including Trading Standards Officers, Public Analysts, Trade Associations, the Medicines and Healthcare products Regulatory Agency (MHRA), Department of Health and the food industry.

An impressive array of speakers guided participants through the complexities of health claims, and the seminar ended with an opportunity to discuss the way forward. The speakers and topics were varied. Dr Katheryn Callaghan (Nutrition Legislation, Department of Health) introduced the legislation and Dr Rosalind Miller (British Nutrition Foundation, BNF) described the Project Bacchus[26] best practice guide for health claims. Enforcement and standards were covered by Liz Moran MChemA (Deputy Head of Scientific Services, Public Analyst Scientific Services Ltd). Katharine Mason (Committee of Advertising Practice, CAP) and Carrie Speer (Advertising Standards Authority, ASA) explained the principles of self- and co-regulation and the approach – with typical adjudications on health claims – of these independent regulators for advertising across all media. Dr Chris Jones (Manager, Medicines Borderline Section of the MHRA) described assessment of borderline products. T. C. Callis (Proprietary Association of Great Britain, PAGB) and Penny Viner (Vice-President, Health Food Manufacturers' Association, HFMA) discussed industry guidance and standards. The feedback was overwhelmingly positive about the guidance and advice received, quality of the lectures, pre-seminar information and instructions, venue and networking opportunities. CPD certificates were sent to those requesting them. A paper has been prepared for the March 2017 edition of the BNF Nutrition Bulletin. The meeting concluded with a discussion and recommendations for future work.

Webinars

In cooperation with Separation Science the Government Chemist provided contributions to a webinar on 'Advances in food safety analysis – Fraud and authenticity'. Selvarani Elahi, Deputy Government Chemist, discussed the new Virtual Food Authenticity Network[27] which aims to raise awareness of the tools available to check for mislabelling and food fraud. It allows consumers to have confidence in the food they buy, ensuring the UK has access to a resilient network of laboratories providing fit-for-purpose testing for food authenticity. Michael Walker then described food fraud, drawing distinctions between food authenticity, food fraud and food crime. He covered some of the current progress being made in the UK to combat food fraud and highlighted the potential analytical priorities of the future. This webinar remains available on demand[28].

[24] http://www.rsc.org/cpd/training/detail/126/analysis-and-examination-of-food
[25] http://www.publicanalyst.com/training/
[26] http://www.bacchus-fp7.eu/
[27] http://www.foodauthenticity.uk/
[28] http://view6.workcast.net/register?cpak=7149952567604342

Later in the year Michael provided a presentation to another Separation Science webinar: 'Advances in food safety analysis – Contaminants, toxins and allergens'. The presentation gave an overview of testing methods for allergens, their advantages and disadvantages, and the current issues in allergen analysis. Michael also discussed challenges in interpreting results. This webinar can be accessed on demand[29].

As part of ongoing dissemination activities, Government Chemist staff have been involved in producing and providing a series of Defra-funded e-seminars on best measurement practice guidance in DNA extraction, real-time PCR, and DNA sequencing for food analysis. These e-seminars are based on the successful range of previous Defra/Government Chemist knowledge transfer events organised by LGC. The aim behind the e-seminars is to make the best measurement practice guidance freely accessible to all stakeholders.

The first e-seminar, entitled 'The application of real-time PCR for food authenticity testing inclusive of the quantitation of equine DNA', is a summary of findings initially disseminated at a knowledge transfer event delivered at LGC in September 2015. The e-seminar describes the scope, purpose and application of the Defra/LGC Standard Operating Procedure (SOP) for a real-time PCR approach for the quantitation of horse DNA, as well as providing guidance and advice on the application of real-time PCR in food authenticity testing in general, with a focus on availability of methods and reference materials.

The e-seminars are available on the Food Authenticity Network website http://www.foodauthenticity.uk/training

[29] http://view6.workcast.net/register?cpak=1930542454232558

The wider advisory function

The Government Chemist also has a role to provide advice on subjects with an analytical measurement dimension to both government (including the European Union and devolved administrations) and the wider community of stakeholders, which includes industry, academia, Non-Governmental Organisations (NGOs) and local government. This is done by means of the provision of specific advice pertaining to aspects of measurement topics on a broad range of policy and regulatory developments, and also providing a proactive scientific and measurement-based support service to those industries where chemical 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.

Addressing scientific issues with stakeholders

We have continued to follow developments of both the UK Chemical Stakeholder Forum (UKCSF) and the Hazardous Substances Advisory Committee (HSAC) by attending meetings of these bodies and, where appropriate, making contributions to relevant discussions. We continue to be the de facto experts on analytical measurement issues within the HSAC, and have been frequently asked to provide an opinion on this where required.

We are active members of the Nanomaterials Environment and Health Government Group (NEHGG), the successor body to the Government Officials Strategy Group on Nanomaterials, led and chaired by Defra. We have contributed to this group by continuing to make our views very clear on the need for valid measurement methods for the determination of nanoparticles in support of the proposed definition of a nanomaterial, and by highlighting developments in measurement science in this novel area.

We provided advice at a FSA Incident Review Workshop organised to review a recall for adulterated cumin. The communications and the input of the Government Chemist were cited with approval by many stakeholders.

We have continued to provide advice through our responses to official consultations (see Box 2). These consultations are carried out by the government (including 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 legislation or regulations, prior to enactment and are considered by legislators to be an important part of the development process for new legislation and regulation. The Government Chemist is well-placed, through the expertise within LGC in a breadth of matters in analytical science, to respond authoritatively and independently to a wide range of consultations which have chemical or bioanalytical measurement implications.

Specific responses given to the consultations from the European Commission included expressing support for all proposals concerning contaminants in food while recognising that some work might be required by laboratories to ensure compliance with the limits for 3-MCPD in infant formula. The Government Chemist also applauded the collaborative approach that the Commission has taken with the food industry to develop the codes of practice for reducing acrylamide levels in the following five food groups:

- potato based products
- cereal based products
- coffee and coffee substitutes
- baby food (by the sector organisations under the umbrella of FoodDrinkEurope)
- plant bakery products (by the International Association of Plant Bakers)

as well as specific codes of practices for the eating out sector, hospitality industry and craft, micro and small food enterprises.

Box 2: Our public consultation responses

Department for Energy and Climate Change (DECC)	Proposed flexible approach to the status of CAS numbers for chemical weapon precursors
Food Standards Agency/ Food Standards Scotland	Joint Consultation Exercise by the Food Standards Agency and Food Standards Scotland on the adulteration of food – setting thresholds for action
European Commission via Food Standards Agency	Consultation on regulatory proposals for mercury in food
European Commission via Food Standards Agency	Consultation on regulatory proposals for acrylamide in food
European Commission via Food Standards Agency	Consultation on regulatory proposals for 3-MCPD and their fatty acid esters and glycidyl esters in food
European Commission via Food Standards Agency	Consultation on regulatory proposals for cyanogenic glycosides in raw apricot kernels and bitter almonds

SCA Committees

The Government Chemist is also represented on the Steering Committee of the Standing Committee of Analysts (SCA). The SCA, sponsored by the Environment Agency, comprises a series of working groups who provide authoritative guidance on methods of sampling and analysis for determining the quality of environmental matrices. Guidance is published as Blue Books within the series 'Methods for the Examination of Waters and Associated Materials'.

During the year Gary Bird (LGC) continued as Chairman and Co-ordinator of the Radiochemical Methods Working Group (WG9) of the SCA. Topics of discussion during this year included the future development of a Blue Book to cover indicative dose, and the possibility of adding amendments to the current Blue Book series to cover sample pooling. Since measurement uncertainty will be included in Water Quality Regulations in 2019, consideration was given as to whether it should be covered in the current Blue Book series, given that there is already guidance in UKAS M3003[30] and various ISO documents.

[30] https://www.ukas.com/download/publications/publications-relating-to-laboratory-accreditation/M3003_Ed3_final.pdf

Disseminating the Government Chemist function to new audiences

Michael Walker spoke at a one-day conference on 'Food allergen analysis and interpretation of results' organised by the Society of Food Hygiene and Technology where he talked about the common means of allergen analysis, their drawbacks and interpretation of results in the context of allergen reference doses. Michael reviewed several court cases involving food allergens, including a forensic investigation of an allergen sabotage incident in a food factory (in which Michael and Kirstin Gray gave evidence at the Crown Court trial), the 'Eurofoods' prosecution and appeal, and the recent rescindment of cumin recalls in Canada and the UK. The meeting attracted 67 delegates mainly from the food services sector and was a good opportunity to disseminate to a new audience the Government Chemist function.

Michael Walker also participated in a meeting on 'Food law in practice' organised by the Institute of Food Safety Integrity and Protection. Michael joined a panel of distinguished speakers including a High Court judge and senior barristers to discuss recent food law developments and the role of the Government Chemist as a technical appeal for food business owners.

Work carried out by the Government Chemist is frequently disseminated through the Food Authenticity Network website[31], which was created through a project managed by Selvarani Elahi, the deputy Government Chemist. The network's aim is to raise awareness of the tools available to check for mislabelling and food fraud, and ensure that the UK has a resilient network of laboratories with fit-for-purpose testing to check for food authenticity. Referee cases disseminated through the network include the cumin and paprika cases described on page 17.

[31] http://www.foodauthenticity.uk/

Laboratory-based studies

The prioritisation process undertaken by the GCPEG prior to the commencement of the 2014-2017 programme identified a small number of proposed project areas which were considered appropriate for small-scale funding. These generally address measurement challenges in non-food matrices with environmental applications.

The following studies were concluded under the 2014-2017 programme:

- Water Framework Directive (WFD). A desk study looking at the current and proposed priority hazardous substances and priority substances listed in the Water Framework Directive and its daughter directives, with specific reference to the ability of environmental monitoring laboratories to measure these compounds accurately at the maximum levels laid down in the regulations. The report highlighted where gaps in measurement capability exist, and also considered the quality assurance tools available to assist environmental monitoring laboratories concerned with the effective enforcement of the WFD and its daughter directives. The report was published on the Government Chemist website[32] and we received positive feedback from both the Environment Agency and the European Commission DG Environment.

- Identification of sustainable timber. A desk study to ascertain whether timber speciation using DNA-based methods was feasible was completed in 2014, and laboratory work was completed in 2016. The laboratory work focused on various species of oak, specifically the extraction and subsequent analysis of oak DNA in order to differentiate species. The findings from this project demonstrate that there is a basis for the identification of timber species using DNA analysis, which could potentially be applied to the identification of 'illegal' timber sources.

- Differentiation of ionic and nanoparticulate silver. Work was also completed on the development of a method to differentiate the ionic, more toxic, form of silver from the nanoparticulate form in the environment. This project developed a novel ICP-MS (inductively coupled plasma-mass spectrometry) methodology capable of differentiating and measuring nano and ionic silver simultaneously in the same sample so that environmental monitoring laboratories can get a much more accurate picture of the ionic silver load in effluent streams and water treatment plants in the UK[33].

[32] https://www.gov.uk/government/publications/water-framework-directive-an-analysis-of-measurement-issues
[33] https://www.gov.uk/government/publications/nanosilver-measurement-of-silver-nanoparticles-in-the-environment

PUBLICATIONS

Publishing peer reviewed papers is integral to our work enabling transparency to the analytical community. A list of papers published in 2016 is presented below.

Two papers in particular appear to have been viewed favourably by the scientific community. Our article on 'The role of knowledge of the history of analytical chemistry for academics and for law enforcement authorities' was published in Analytical and Bioanalytical Chemistry and reprinted in several other learned journals. Our paper on residues of the veterinary medicine albendazole has also been referred to in several other matters for the guidance it has given on sampling in complex situations.

Nixon G., Hall L., Wilkes T., Walker M., Burns M., Novel approach to the rapid differentiation of common *Prunus* allergen species by PCR product melt analysis, Food Nutr. Sci., 2016, 7, 920-926

Burns M., Walker M., Wilkes T., Hall L., Gray K., Nixon G., Development of a real-time PCR approach for the specific detection of *Prunus mahaleb*, Food Nutr. Sci, 2016, 7, 703-710

Burns, D., Walker, M., Buchberger, W., Worsfold, P., The role of knowledge of the history of analytical chemistry for academics and for law enforcement authorities, European Analytical Column No. 44, Anal. Bioanal. Chem., 2016, 408 (16), 4191

Walker M. J., Burns D. T., Elliott C. T., Gowland M. H., Clare Mills E. N., Is food allergen analysis flawed? Health and supply chain risks and a proposed framework to address urgent analytical needs, Analyst, 2016, 141, 24-35

Walker M., Gray K., Hopley C., Mussell C., Clifford L., Meinerikandathevan J., Firpo L., Topping J., Santacruz D., Resolution of a disputed albendazole result in the UK Official Control System – time for more guidance, Food Addit. Contam.: Part A, 2017, 34 (4), 489-493

Wilkes T., Nixon G., Bushell C., Waltho A., Alroichdi A., Burns M., Feasibility study for applying spectral imaging for wheat grain authenticity testing in pasta, Food Nutr. Sci., 2016, 7, 355-361

Wilkes T, Nixon G., Burns M., Recent developments in DNA-based screening approaches for detection of GMO's, J Assoc. Public Anal., 2016, 44 040-050

Burns M., Wiseman G., Knight A., Bramley P., Foster L., Rollinson S., Damant A., Primrose S., Measurement issues associated with quantitative molecular biology analysis of complex food matrices for the detection of food fraud, Analyst, 2016, 141, 45-61

Elahi S., Lawrance P., Topping J., Ellison S., Woolfe M., Poultry marketing controls – Inter-laboratory validation of a method to detect previously frozen chicken breasts by determination of HADH activity, Food Control, 2016, 68, 186-191

GLOSSARY

See the International Vocabulary of Metrology[34] for the current definitions of terms used in measurement science

ADI	Acceptable daily intake
APA	Association of Public Analysts
ASA	Advertising Standards Authority
BEIS	Department for Business, Energy and Industrial Strategy
BNF	British Nutrition Foundation
CAP	Committee of Advertising Practice
CRM	Certified reference material
Defra	Department for Environment, Food and Rural Affairs
DIT	Department for International Trade
DNA	Deoxyribonucleic acid
EFSA	European Food Safety Authority
ELISA	Enzyme-linked immunosorbent assay
FBO	Food or feed business operator
FDF	Food and Drink Federation
FSA	Food Standards Agency
FSS	Food Standards Scotland
GAFTA	Grain and Feed Trading Association
GCPEG	Government Chemist Programme Expert Group
GCSA	Government Chief Scientific Adviser
GMO	Genetically modified organism
HFMA	Health Food Manufacturers' Association
HSAC	Hazardous Substances Advisory Committee. Expert committee providing advice to Government on hazardous substances, toxicology, risk assessments

ICP-MS	Inductively coupled plasma-mass spectrometry
IDMS	Isotope dilution mass spectrometry
ITS	Internal transcribed spacer
JRC	Joint Research Centre
LC-MS/MS	Liquid chromatography-tandem mass spectrometry
LLM	Master of Law
MBA	Master of Business Administration
MChemA	Mastership in Chemical Analysis – this Royal Society of Chemistry qualification is required for appointment as a Public Analyst or as an Official Food Analyst
NEHGG	Defra-led Nanomaterials Environment and Health Government Group
NGS	Next generation sequencing
NMR	Nuclear magnetic resonance
Official Food Analyst	A person qualified under the Food Safety (Sampling and Qualifications) Regulations (1990 and/or 2013) (see also MChemA and Public Analyst)
PAGB	Proprietary Association of Great Britain
PCR	Polymerase chain reaction, a technique used to amplify DNA sequences so that they can be identified
Port Health Authority	Special type of local authority created to ease administration at seaports where the port area is covered by more than one local authority, responsible for carrying out checks on food and feed consignments
Public Analyst	Analytical scientist appointed under statute by UK local authorities to provide an official food or feed control function and scientific advice for the enforcement of many acts of Parliament

[34] International vocabulary of metrology – basic and general concepts and associated terms (VIM), Third Edition, JCGM 200:2012, http://www.bipm.org/en/publications/guides/vim.html

GLOSSARY

RSC	Royal Society of Chemistry
Referee analysis	Impartial analysis by the Government Chemist to help resolve disputes relating to test results obtained on behalf of two independent parties
Referee function	Duty of the Government Chemist under acts of Parliament to provide impartial analysis in the resolution of disputes relating to the enforcement of regulation
SCA	The Environment Agency's Standing Committee of Analysts
SEO	Supplementary expert opinion in the context of Regulation (EC) No 882/2004 on official controls, Article 11(5)
SI	International System of Units
SOP	Standard Operating Procedure – a documented method for analytical measurements
SSA	Seasoning and Spices Association
Tandem mass spectrometry	Use of linked mass spectrometers; molecules of interest can be broken up after the first stage to allow more detailed characterisation by analysing their fragments in the second
UKCSF	United Kingdom Chemical Stakeholder Forum
WFD	European Union Water Framework Directive

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