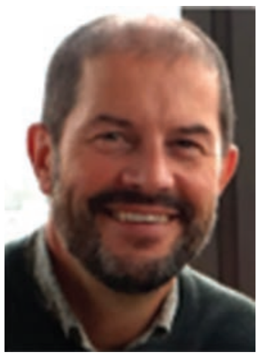
Food Analysis has Never Been so Challenging or Exciting

Graham Meller

We recently interviewed Tim Lumb, Chemistry Technical Manager for ALS; one of the world's leading providers of food and drink testing services. Tim is responsible for driving innovation in the company's laboratories; developing new methods and evaluating new technologies to help meet the ever-changing needs of customers and regulations.



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Tim Lumb

1. How and why did you develop a career in food testing?

Tim: Like most people, I am very interested in food, but I have always had an aptitude for chemistry, so it was no surprise when my first job was a laboratory technician measuring the sugar content of foodstuffs. Over the next 15 years I must have performed every possible role in a food testing laboratory, and this has enabled me to develop my understanding of the testing and analysis of a wide range of materials, with a broad spectrum of analytical techniques and methods. This work has included due diligence activity for acquisitions, as well as overseas postings; overseeing the integration of an acquired laboratory in Portugal, for example.

As a consequence of this experience, I have become Technical Manager for ALS in the UK, Food Chemistry Technical Lead in the EU, and Innovation Coordinator. All of which combine to provide a challenging but hugely rewarding job in which I am constantly looking for ways to analyse new parameters, in different materials, at lower levels, faster, with greater accuracy, and at a lower cost than ever before.

2. Can you tell us a little more about ALS?

Tim: ALS is a leading testing, inspection, certification and verification company, with its headquarters in Australia. Servicing multiple industries globally, ALS employs over 15,000 staff in more than 65 countries. The Group has three main divisions: Commodities (Geochemistry, Metallurgy, Mine Site, Coal and Inspection); Life Sciences (Environmental, Food & Pharmaceutical, Animal Health and Electronics), and Industrial (Asset Care and Tribology).

The ALS food testing laboratories provide consultancy services as well as a comprehensive range of analytical tests including microbiological, nutritional, vitamins and minerals, pesticides and contaminants, allergens and speciation. In the food and beverage market our work is designed to provide assurance that products are (1) Safe, (2) Nutritious and (3) Authentic.

3. Can you briefly describe the most common tests in your laboratories?

Tim: At ALS our aim is to provide a one-stop-shop for food and beverage testing, so we have established a 'hub and spoke' system in which our local laboratories focus on the most popular tests, and the hub labs deliver a full service and some of the more specialist services.

The largest volume of tests that we perform are microbiological to ensure the quality and safety of food destined for supermarkets. Food microbiology testing includes a range of pathogens such as Salmonella, Listeria, E.coli etc. Given the volume of work required, our microbiological labs are often located close to food manufacturers. In addition to routine microbiological analysis of food samples, we also provide shelf-life evaluation, environmental monitoring, hand swabs for Staphylococcus aureus and E.coli for example, and water testing.

Nutrition tests are generally performed for 'back of pack' purposes, providing data on the levels of Water, Ash (drying ovens), Protein (Kjeldahl or Dumas combustion), Total Fat (NMR), Fibre (enzyme digestion), Sugar (HPLC), Fatty Acids (GC), Sodium (ICP), etc.

Authenticity testing involves a variety of techniques for checking characteristics such as provenance; ensuring that Parma ham is from Parma for example. Content verification is an important part of our work. This might be checking that the only meat in a beef lasagne is beef, or that the white fish specified on a label has not been substituted by something else. Authenticity testing has been greatly enhanced by the development of genetic testing using PCR (Polymerase Chain Reaction) instrumentation.

Next-generation sequencing (NGS) is also employed for testing vegetables, meat and fish, this allows for testing of multiple species simultaneously.

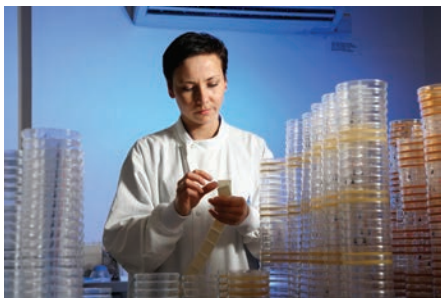
The requirement for testing allergens continues to grow, and involves a variety of techniques. For example, ELISA (Enzyme Linked Immunosorbent Assay) methods are utilised for the identification of specific proteins such as gluten, soya and egg; PCR enables the detection of potential allergens such as celery, and sulphites can be measured by distillation with the Monier–Williams method.

Pesticide testing is also necessary for fresh produce as part of supermarket due diligence. Testing is also required for the certification of organic produce, and during harvest periods some farmers send crop samples for same-day analysis to facilitate timely harvesting.

Vitamin testing, using HPLC, GC, microbial, or fluorometric techniques, is more commonly required for the analysis of beverages, baby food and dairy products.

4. Are your food and beverage laboratories able to also test other materials? For example, some clothing manufacturers do not currently wish to purchase cotton from a specific region in China.

Tim: Yes, we also conduct analytical tests for a wide variety of non-food samples, and this is a key focus for many of the ALS centres of excellence. We are able to determine the country of origin for agricultural products. Normally, we would employ stable isotope analysis, based on a chemometric statistical profile, so analysis would need to be performed on a reference data set of cottons from the various regions. If the analysis was on a finished product it might be made too complicated due to the processing chemicals, but it is certainly possible on raw cotton. In addition, it may be possible to look at O and H isotopes for the water used in certain districts which might give an indication of where a product is processed, but this would be more challenging than the base agricultural product.



5. What are the main drivers for food testing?

Tim: International and domestic regulations have been established to protect the safety and quality of food. These relate to the entire food chain and to both safety and consumer information issues relating to food. In addition, many organisations require testing to demonstrate compliance with requirements that are more closely associated with marketing than safety.

EU Regulation No 1169/2011 requires the vast majority of pre-packed foods to bear a nutrition declaration for the key parameters such as energy, sugars, saturates, carbohydrate, fat, protein and salt. The content of the mandatory nutrition declaration may be supplemented voluntarily with the amounts of mono-unsaturates, polyunsaturates, polyols, starch, fibre, vitamins and minerals. The 14 groups of substances or products causing allergies or intolerances are listed in Annexe II of the Regulation.

As part of an initiative to build confidence in the food supply chain, the Global Standard for Food Safety was first published in 1998. It provides a framework to manage product safety, integrity, legality and quality, and the operational controls for these criteria in the food and food ingredient manufacturing, processing and packing industry.

The Food Safety Act 1990 provides the framework for all food legislation in the England, Wales and Scotland. The Act ensures that businesses do not include anything in food, remove anything from food or treat food in any way which means it would be damaging to the health of people eating it. Food must be of the nature, substance or quality which consumers would expect, and food must be labelled, advertised and presented in a way that is not false or misleading.

Food safety procedures are based on Hazard Analysis and Critical Control Point (HACCP) principles, and this analysis usually necessitates testing of physical, chemical or microbiological factors.

6. Which instruments are the workhorses and which instruments are required for specialist work?

Tim: The fascination that I have for food testing is driven in part by the diversity of instruments that are necessary to provide a comprehensive testing service. Innovations are constantly emerging to improve our capabilities, but some of our key technologies include:

- Desktop NMR – our latest instruments are compact, extremely robust, fast (12 MHz) and simple to operate. As a result, we are able, for example, to measure Total Fat in just 20 seconds.
- GC-FID and HPLC – the analysis of vitamins and food additives is now commonplace with these technologies.
- ICP-OES – ideal for the analysis of parameters such as Ca, Cu, Fe, K, Mg, Mn, Na, P, and Zn
- Ion Exchange Chromatography – ideal for anions, cations and polar substances. This is typically used for carbohydrate analysis in food.
- ICP-MS – routinely employed for Ca, Hg, As, Cr and Pb. Mercury is highly toxic and is a particular concern in fish such as tuna that are high in the food chain, as well as in some herbs and spices.

In addition to these analytical technologies we also employ specialist instruments such as:

- Triple Quad Mass Spectrometers for the measurement of pesticides, antibiotics and mycotoxins
- High Resolution GC-MS for Dioxins and PCBs
- Stable Isotope Analysis for geographic testing; to check the provenance of Sicilian lemons for example.

One of the company's most specialised instruments is a Multi Collector ICP-MS, which is a hybrid mass spectrometer that combines the superior ionisation of an inductively coupled plasma source with the precise measurements of a magnetic sector multicollector mass spectrometer. Based in the ALS laboratory in Sweden, this instrument offers speciation of metals at trace levels in food, electronic, and environmental applications. It is even able to identify the production site for pharmaceutical products.

7. What are the current trends in food analysis?

Tim: There are three major trends at the moment. Firstly, allergen analysis was almost non-existent as recently as ten years ago, but now forms a significant part of our workload, and all of our labs now have this capability. Secondly, following the publication in 2014 of the Elliott review into the integrity and assurance of food supply networks, the volume of food authenticity tests has grown rapidly. Thirdly, toxicity testing is becoming more important as global warming upsets ecosystems; shifting seafood toxins for example, and increasing mycotoxin levels in previously cold grain growing regions of the world.

8. How important is Method development?

Tim: Text book methods are very basic, so they need to be adapted to suit the appropriate laboratory equipment, and incorporated into lab SOPs in sufficient detail to make them easy to follow for technicians. For commercial laboratories, the major goals are to make tests faster, lower in cost, and with improved sensitivity, repeatability and reproducibility. We are therefore constantly seeking to develop new methods that can help achieve these goals whilst also responding to new testing requirements. This is only possible by building partnerships with customers, instrument manufacturers and academia, so, yes – method development is critically important for us.

9. Has Covid affected the food testing market?

Tim: Yes, the pandemic has affected the market in many different ways, but our laboratories have responded accordingly to ensure that we maintain the provision of our essential services. Obviously, the food supply chain has been subjected to a number of shocks which have resulted in greater risk of ingredient substitution and reduction of product quality. The food supply chain has therefore had to heighten vigilance and this has increased the demand for testing. We have also expanded our testing services to include SARS-COV2 using PCR for human samples and environmental swabs, through our specialist laboratory in Portugal.

10. Looking forward, how will things change in the food testing/analysis lab?

Tim: In common with the rest of industry, many traditional practices are being automated with the use of smart technology (Industry 4.0). Increasingly, machine-to-machine communication (M2M) and the internet of things (IoT) are being integrated with laboratory procedures and LIMS, to standardise many tasks and diagnose issues without the need for human intervention.

Analytical data is only valuable once it is in the hands of those that need it, so the integration of LIMS with online resources will mean that the food supply chain will be able to make faster, better informed decisions.

Automation helps to reduce the potential for error, enable 24/7 operation and increase both speed and throughput capacity. In the laboratory, automation is now expanding to include collaborative robotics, and force limited robots are able to improve safety. In time, machine learning will improve the processing of data and should help in the validation of results.