HOW MUCH TESTING DO WE NEED?

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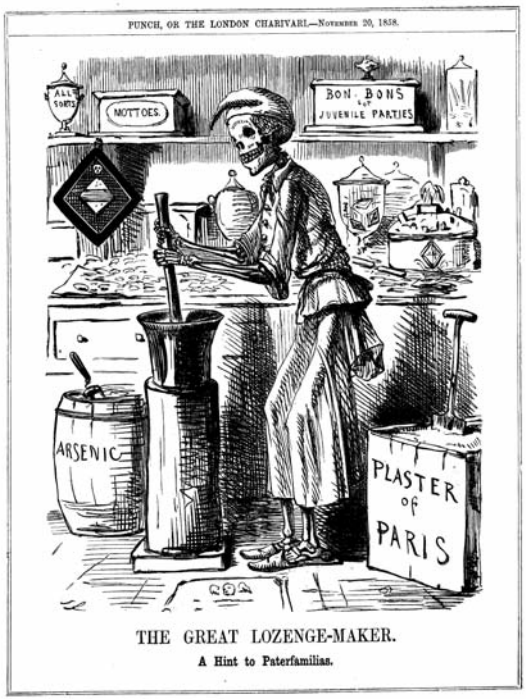
HISTORICAL BACKGROUND

Food fraud has been around since food was traded and the further the distance that food travels the more likely it is to be adulterated. Prior to the industrial revolution it was only truly exotic foods which were routinely adulterated. The movement of people from rural areas where their food was produced into towns during the 19th century led to basic foods such as flour and milk being targeted by unscrupulous traders. At this time sugar was a luxury food as it was common to use plaster of Paris in sweets. On an occasion in Bradford in November 1858 a pharmacist's assistant made a mistake and supplied the sweet maker with white arsenic powder instead. Twenty people died in agony and another 200 people were seriously ill.



A cartoon from Punch of 20th November 1858 calling for action to prevent food adulteration.

The worsening problem led to the passing of an Act to prevent the adulteration of food and drink in August 1860. This legislation was not a success and it was not until 12 years later that a more workable statute came into force. The 1872 Act gave sampling officers powers, required authorities to appoint a public analyst, defined what food and drugs were and created the offence of "selling to the prejudice of the purchaser any food not of the nature, substance or quality demanded". This offence exists today in Section 14 of the Food Safety Act 1990. The first public analysts had a difficult job, analytical chemistry was very much in its infancy and what was actually meant by adulteration had not been defined. In 1898 it became a requirement for Public Analysts to hold a qualification and that is still the case today: the Mastership in Chemical Analysis is a competence based qualification administered by the Royal Society of Chemistry.

Moving on about 100 years we come to the creation of the Food Standards Agency. The Food Standards Act 1999 sets the main objective of the agency in carrying out its functions ie "to protect public health from risks which may arise in connection with the consumption of food and otherwise protect the interests of consumers in relation to food".

When we think of health we often think of the acute risks that arise from food poisoning be it E. coli O157 or listeria. However, there are also chronic effects, be they from too much salt in the diet, or high levels of heavy metals in seafood.

The other part of the Agency's function "otherwise to protect the interests of consumers in relation to food" covers much of the work of Public Analysts and is the area in which the horsemeat scandal rests. Is it what it says on the burger box?

LOCAL AUTHORITY ENFORCEMENT

Local Authorities play a large role in enforcing food regulations. Where there is two tier local government the district councils are responsible for enforcement of food hygiene and the counties for food standards. In areas with single tier administrations both are dealt with within the same authority. During the media frenzy around the horsemeat scandal there was much confusion about terms so it is worth just clarifying some of them.

Generally when the term food safety is used what is meant is food hygiene and the microbiological safety of food. Food standards covers non-microbiological aspects of food safety such as toxicological risks from pollutants and other toxic substances. It also covers food fraud, labelling, authenticity, diet and health as well as foreign bodies in food.

Part of the local authority enforcement activity includes taking samples, both for microbiological examination (food hygiene) purposes or for chemical analysis (food standards). As the horsemeat

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scandal progressed, media attention focused on the decline in sampling rates over the last few years. Notable quotes derived from the Local Authority Enforcement Monitoring System (LAEMS) returns submitted to the Agency by local authorities included "Food protection tests slashed by a third in Scotland" (Sunday Herald 17th Feb 2013). "For County Councils [in England] the number of food samples taken for analysis by public analysts has fallen by 47% in the three years to March 2012" (Yorkshire Post 5th Feb2013). "Seven million people [in England] live in areas where [Local Authorities] are not doing any [Food Standards] sampling at all." (Independent on Sunday 17th Feb 2013).

This reduction in sampling has been mirrored by a reduction in the number of Public Analysts and the closure of laboratories with four closing or ceasing to carry out official control work in the last 3 years.

The analysis of samples is only part of the controls on food but it is worth emphasising that many criminal breaches of food law, deliberate or accidental, are only detectable by analysis. Analysis and interpretation of the results of that analysis in the context of the law is what Public Analysts do. This requires a wide range of skills and instrumentation, some of which is familiar to anyone who has studied chemistry at school. At the other end of the spectrum are sophisticated and highly sensitive instruments such as a high performance liquid chromatograph coupled with a tripe quadruple mass spectrometer (LC-MS-MS) and the Real-time PCR techniques used to detect the presence of minute amounts of DNA. Most public analyst laboratories carry out other functions as well as those of official food and feed control. This ranges from air pollution monitoring to testing of consumer goods, asbestos and legionella surveying and testing, and providing scientific support to the emergency services.

There is some specialism in laboratories but its scope is limited by competition for the ever diminishing amount of official work.

FOOD FRAUD

We have all probably been victims of food fraud at one time or another. We may only suffer financially having paid a premium for wild salmon, extra virgin olive oil, organic produce or heather honey but getting a cheaper but perfectly safe product. An exception to this is in the supply of counterfeit or fake vodka where the liquid in the bottle contains one or more toxic compounds such as methanol, chloroform or xylene.

The Food Fraud Task Force in its final report (September 2007) noted "in some cases the food fraudster can apply highly sophisticated techniques and make it very difficult, if not impossible, for the public to detect that food fraud has occurred. Thus, as part of food fraud control enforcement there much be an equally sophisticated analytical service to support the food enforcement officer in the field".

There are some parallels between the horsemeat scandal and the Sudan I scare; Sudan I is a carcinogenic dye which was found in chilli powder in 2003. Laws were introduced across the EU to ensure that consignments of chilli powder were tested on entry. Then in 2005 Sudan I was found in Worcester sauce by scientists in Italy. It had been manufactured in the UK long after the problem had been identified and found its way into many different foods. A huge recall operation was carried out with 580 products being withdrawn. In the wake of this incident a review panel was set up and one of its recommendations was for the Agency to ascertain the UK laboratory capacity available to assist in major incidents such as the Sudan I scare and pursue the matter within Government if it was deemed to be insufficient.

DNA testing using the Polymerase Chain Reaction was very much in the news during the horsemeat scandal. Ten years ago there wasn't much PCR analysis going on in Public Analyst laboratories. In 2006 the Agency helped fund PCR instruments resulting in the equipment being in place in 11 laboratories. However due to laboratory closures and other factors only six laboratories were able to analyse samples for the presence of horsemeat DNA. This is a reflection of the way that official control laboratory capability and capacity is funded in the UK which is solely through local authorities spending money on analysis. As demand has fallen, so has the supply.

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HOW MUCH TESTING DO WE NEED?

Although central targets are set for the numbers of inspections, none are set for sampling rates. In 2001 it was noted that this had resulted in an increase in the number of inspections but a decrease in the number of samples taken. These decisions are taken locally but, as we have seen, food and its ingredients travel long distances. Levels of enforcement both in terms of inspection and sampling vary widely across the country and there is no central strategic direction or funding to ensure that appropriate resources are in place where they are needed at a local level.

It is frequently stated that local authority sampling is risk based. In my experience this is not the case. Local authority enforcement officers will make the best use of the resources available. They do this within the constraints of available staff and budgets. This is not the same as, firstly, assessing the risks posed by the food business in their area and deciding how many suitably qualified staff are required to carry out adequate inspections and audits. Then, in consultation with a Public Analyst, deciding on the number of samples to be taken and the money required to perform appropriate analysis on them.

Some food businesses have only a local impact but many, either through their own products or supermarket own brands, will be sold across the country. Under the current system there is an unacceptably wide variation in the level of official controls. There is a need for local delivery but also for central funding and strategic direction.

CONTAMINANTS IN FOOD

Elizabeth Moran
President of the Association of Public Analysts

INTRODUCTION

Contaminants are chemical substances that have not been intentionally added to food or animal feed. Their presence in food can pose a risk to animal or human health. They may be present in the environment either in a naturally occurring or man-made form and can also be produced in food and feed during processing.

CONTAMINANTS

The most common contaminants found in food and feed are indicated below:

Heavy Metals

Heavy metals include arsenic, lead, cadmium and mercury. These metals can be naturally-occurring or present in the environment due to industrial contamination. Heavy metals occur in the environment and may be present at quite high levels in some foods like fish and shellfish, though normally in a non-toxic form. Consumption of foods containing toxic forms leads to chronic toxicity.

Heavy metals bio-accumulate particularly in meat and fish and are often found in dried herbs, spices and other foods.

Nitrates

Ammonium nitrate is a common fertiliser which can often make its way into crops, soil and water courses. Although not in itself harmful, nitrate can form nitrosamines which are carcinogenic. Nitrates are found in agricultural crops such as winter lettuce and spinach and levels need to be carefully monitored.

Mycotoxins

Mycotoxins are toxic compounds produced by moulds (myco) growing on plant products. There are several different types depending on the plant and what part of the world it is grown and harvested in. Good agricultural practice should limit the development of mycotoxins on crops but factors such as wet or damp weather, poor drying or storage conditions all lead to problems. The bad winters of the last three years in Europe have led to very high levels of mycotoxins in cereal crops. Some examples are:

- Aflatoxins – aflatoxin B1 is produced by *Aspergillus* moulds. This mould commonly grows on nuts, fruits and grains. Aflatoxins cause cancer and liver damage and are particularly harmful to birds. Aflatoxins consumed by dairy cows can lead to the presence of aflatoxin M1 in milk.
- Ochratoxin A – found on vine fruits and coffee.
- Tricothecenes, Fumonisins and Fusarium toxins are found on cereal crops such as wheat, barley and oats.

Process Contaminants

Certain chemical compounds may not be present in any of the food ingredients but are produced during processing or heat treatment as a result of chemical reactions. Some examples are:

- 3-Monochloropropanediol (3-MCPD) in non-naturally fermented soy sauces that have been made via protein hydrolysis using hydrochloric acid, and can also occur in processed meat products, bread and crackers. 3-MCPD is carcinogenic and possibly genotoxic.
- Acrylamide occurs naturally in cooked starchy foods, eg chips, bread, bakery products. It was first discovered in Sweden in 2002. It is carcinogenic and is also found in black olives and dried coffee.
- Melamine is a white crystalline powder used as a heat-retardant (eg in kitchen work surfaces). It has been used illegally as a protein substitute in pet food and infant formula from China, which led to many pet deaths in the USA, but then to the death and health problems such as kidney stones in infants in China.

> . . . proportion of GM soya on the world market has increased . . .

Dioxins

Dioxins are a group of over 200 chemical compounds containing chlorine which are persistent in the environment. Their presence is mainly due to incineration and the chemical industry. They accumulate in animals and fish and are found in meat, fish, eggs and dairy products.

Polychlorinated biphenyls (PCBs)

PCBs consist of over 200 organo-chlorine compounds with 2 to 10 chlorine atoms. PCBs were widely used as dielectric and coolant fluids, for

. . . occur in foods cooked or processed in certain ways . . .

example in transformers, capacitors and electric motors. Their use is no longer permitted in most countries but they are persistent in the environment and PCBs are harmful.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAHs are synthesised as a product of combustion and are found in high levels in vehicle emissions and cigarette smoke. They also occur in foods which have been cooked or processed in certain ways, eg traditionally smoked foods, flame-grilled or barbecued food, processed cereal products, dried herbs, herbal supplements and dried vegetables.

Radiation

Foods are irradiated to kill microbes in food which may be harmful to health. If food has been irradiated this must be declared on the product label. Irradiation has been abused in the past to make food which is unfit for consumption 'safe'. Commonly irradiated foods include dried herbs and spices, food supplements, dehydrated Asian meals, soups, sauces and garlic.

A maximum limit of 600 Bq/kg for radioactive Caesium has been set for foods such as wild mushrooms, cranberries and bilberries from non-EC Eastern European countries affected by nuclear fallout from the Chernobyl accident in 1986.

Genetically Modified Organisms (GMOs)

Many GMOs are authorised for sale in food and feed in the EU but their presence must be indicated. Separation of GM and non-GM commodities such as soya has become increasingly difficult as the proportion of GM soya on the world market has increased. Unauthorised GM products which have not undergone a safety assessment have also been detected in foods in the European Union including in rice products from China.

Veterinary and Pesticide Residues

Antibiotics and other drugs used in the treatment of animal disease should be withdrawn from use in good time before animals destined to enter the food chain are slaughtered. Residues of these drugs are found in meat and fish products due to inappropriate use, not in compliance with Good Agricultural Practice. Examples are the illegal use of drugs such as clenbuterol and hormones and levels of permitted drug residues above the Maximum Permitted Residue Limit (MPRL).

Pesticide residues on food can arise for similar reasons such as the illegal use of compounds like DDT or lindane and levels of permitted pesticides above the Maximum Residue Limit (MRL) due to use of excessive amounts of pesticide or use of pesticide too close to date of harvesting.

Illegal Dyes

Farmers and producers add colours to food to boost their appearance and market value. These colours may be harmful to health and not approved for food use. In 2003 Sudan red dye was found in chilli powder used in hundreds of ready meals, sparking one of the biggest product recalls ever in the UK.

Food Contact Materials

Harmful chemical compounds in plastic-ware which comes into contact with food such as kitchen utensils, containers and packaging can leach into food. Examples are primary aromatic amines (PAAs) in kitchen utensils and formaldehyde in melamine ware, eg picnic sets.

IMPORTED FOOD ISSUES

Over the last few years certain contaminant issues have cropped up with food being imported into the UK from other parts of the EU or from outside the EU (third countries). Examples are aflatoxins in peanuts and figs, ochratoxin A in dried fruit, antibiotic residues in honey from China and illegal dyes in farmed fish and spices.

SPIRIT DRINKS

The UK is currently dealing with a high occurrence of adulterated and counterfeit spirit drinks, particularly vodka. The relatively high price of alcohol and the economic recession may partly explain this. Problems encountered include counterfeit products made with industrial alcohol which can be extremely harmful if consumed, causing blindness, paralysis and death. Substitution of well-known quality brands with cheaper versions is also a big problem, particularly in pubs and night clubs.

HEALTH EFFECTS OF FOOD CONTAMINATION

Compared with the nineteenth century few people appear to die as a direct result of eating contaminated food. Some contaminants, such as lead, cause acute or chronic effects. Aflatoxins were responsible for causing acute liver failure and the death of many children in a village in Nigeria just a few years ago. But the long-term effects of consuming contaminated food are more difficult to see.

Many organic (used in the chemical sense) contaminants are carcinogenic, mutagenic and teratogenic. Consumption of very small amounts in foods over many years can lead to build-up in the body. The variety of foods consumed which are sourced from many countries around the world means that the range of contaminants the population is now exposed to is probably much greater than at any time in history. The global scale and complexity of the food chain mean that it is very difficult to monitor the levels of contaminants in food and a great deal of emphasis must be placed on traceability and paperwork. However, in the UK, testing of many food and animal feed products is carried out by public analysts for local authority food safety enforcement officers, port health authorities and the Food Standards Agency. The results of analysis show that while the majority of food contains contaminants below unsafe limits, many products do continue to give rise to problems and constant vigilance is required to ensure the safety and security of the food we eat.

TESTING FOR CONTAMINANTS

Testing of food and feed for contaminants is therefore a very important tool to be used alongside traceability and audit procedures and the UK should ensure that the amount of testing carried out is adequate to ensure the population is not exposed to grossly contaminated food on a regular basis and that future widespread contamination incidents are avoided.

. . . Good agricultural practice should limit the development of mycotoxins . . .

FSA'S ROLE IN FOOD TESTING AND ASSURANCE

Dr Patrick Miller
Head of Science Strategy and Governance, FSA

ROLE OF TESTING

Testing is part of a wider framework of checks and assurance on food that ensure food is safe and what it claims to be. This is the responsibility of food businesses to ensure that this is the case. They do this through their own controls, checks and testing.

Of course government has a role – we don't just leave the industry to it. Our role is to ensure there is effective, proportionate regulation and enforcement that helps businesses comply with their responsibilities, and to ensure there are rigorous, risk-based checks that this is happening in practice, and action where it is not.

The Food Standards Agency is the UK's Competent Authority for food. As such we have a lead and co-ordinating role, which we fulfil by working in partnership with Local Authorities (LAs), Public Analysts; Defra and other Departments, and with other scientists, the food industry and consumers.

Testing is an important part of this. But there are hundreds of thousands of food businesses in the UK – and any of the large retailers, for example, may have something like 30,000 product lines and it becomes clear that we cannot test everything.

Neither should we rely on testing as the first line of defence: that is provided by effective control and assurance over production, processing and supply chains, and by careful checking of these systems by LAs. Two key elements of this, which have proved effective in practice, are risk-based food safety systems – such as those based on HACCP (Hazard Analysis of Critical Control Points), and traceability – so that every food business has an up-to-date audit trail at least one stage back and one stage forward.

Testing can help underpin these measures. It is more efficient to focus testing on raw materials and ingredients, and key points in production to ensure process control, than on finished products – this allows you to pick up issues earlier, and to avoid wastefully producing food that later needs to be disposed of.

Alongside this we need to gather and share intelligence on risks. We also need to keep up with the science, to understand what testing is telling us and what the appropriate response is – for example, how to respond to the ability to detect increasingly low levels of material that would have been undetectable only a few years ago.

Testing thus provides an essential check that controls are achieving the desired result; it can help to provide assurance, to identify problems, and to target remedial action. We need an effective level of testing. But it is not by itself the best or the primary means of achieving control.

WHAT TESTING IS DONE?

Most food law enforcement is delegated to LAs under the Food Law Code of Practice, which requires them to have risk-based sampling and checking programmes in place. These include verifying food safety and standards controls in food businesses, and testing to reflect local and national priorities. The FSA audits LAs to make sure these programmes are effective. We also support LAs through facilitating exchange of good practice, training for officers, a fighting fund to help with enforcement with unexpected resource implications, and grants for LA tests against risk-based priorities.

. . . FSA does not control local funding . . .

There are two complementary strands of activity. First there are the tests and checks that LAs plan and fund at the local level, drawing on their detailed knowledge and experience of the food businesses in their area to target local priorities. This work is funded from local budgets. FSA does not control local funding but we work with local government to highlight the importance of food checks and

. . . meat authenticity as a priority . . .

the types of check we regard as priorities.

The second strand is the National Co-ordinated Sampling Grants Programme funded and co-ordinated by FSA, working with Defra and other departments. This provides additional funds for LAs to carry out co-ordinated testing on products and issues which are a priority at national level, based on evidence and intelligence of particular concerns. The focus is mainly on food safety risks and what could make people ill, but the programme includes checks on information and authenticity where we have reason to believe there may be problems.

In 2012/13 we provided £2 million in this programme and we will provide a similar amount for the 2013/14 programme, which includes meat authenticity as a priority. Funding can cover resource needed to carry out testing as well as the cost of the tests themselves.

Alongside this, the Health Protection Agency (HPA) funds its own laboratories to provide a resource for LAs to have testing done on microbiological safety in food, at no cost to the LA.

In 2011/12 local authorities took 78,653 food samples, which underwent 92,181 analyses by Official Control Laboratories – including 18,219 analyses on composition, 11,879 on labelling and presentation, and 55,546 microbiological analyses.

REPORTING

With all this testing, it is essential that data are shared on what's being tested and on the results. LAs report information to FSA on food and feed testing via two monitoring systems: LAEMS (Local Authority Enforcement Monitoring System) and UKFSS (UK Food Surveillance System). LAEMS covers annual summary information on LAs' statutory food enforcement activity and outcomes (total numbers of inspections and of samples, and overall compliance levels). UKFSS is used by an increasing number of LAs to record the details of individual food and feed sampling activities and results. This co-ordinated reporting gives the FSA and the LAs a picture across the UK of any non-compliant samples, and also where products get the all clear – which, let us not forget, is the majority of cases, even though testing targets areas of potential concern – and helps us to spot gaps and avoid duplication.

TESTING AS PART OF THE WIDER PICTURE

This adds up to a lot of testing, but this is by no means all that is done to check the safety and quality of the food being sold and eaten in the UK.

LAs assess food premises to ensure they are properly run, identify areas for improvement and ensure these are addressed, including through prosecutions where appropriate, and we support them in this. They also check third country imports entering the UK. This helps pick up issues before they get into the production and retail chain.

FSA carries out official inspections at abattoirs and meat plants to ensure meat hygiene rules are followed. We spend about £1m each year on our own surveys on chemical and microbiological contamination of foods. We fund the UK's statutory monitoring for dairy and shellfish hygiene and radiological safety (about £8m in 2011/12), covering thousands of tests, and we provide £1m of support to National Reference Laboratories for food and feed testing, and for training for LAs.

Defra's food authenticity programme (which moved from FSA in 2010) has funded 17 'snap-shot' national surveys on food mis-description and compliance with food standards legislation. And there are national testing programmes on residues of veterinary medicines and of pesticides in food and feed, carried out by the Veterinary Medicines Directorate and the Health and Safety Executive, each covering thousands of samples each year. FSA provides input on the testing and priorities for these programmes, and we work closely with the Health Protection Agency on their monitoring of foodborne illness.

. . . surveys on chemical and microbiological contamination of foods . . .

All this takes place in the context of work across Europe, in ongoing programmes and ad hoc exercises such as that currently under way on horsemeat. We share information with our European and international partners, which helps build up a picture of the food system and to inform future priorities. European countries share information on adverse results through the EU's rapid alert system (RASSF), so that where problems are identified, we can act quickly to remove them from the food chain.

The final piece of this picture brings me back to my first point – which is testing and assurance by the food industry on the products it is selling. We have seen in response to the horsemeat contamination that industry has carried out, and reported, over 5400 tests for horse in meat products in the space of a few weeks, and that over 99% of these are not affected. This has helped address some of the concern about the potential scale of the issue and about industry's control of its processes. It is unprecedented both in scale and in industry's willingness to share and publish its results. This kind of transparency in industry testing and assurance could be really valuable for future assurance across the food system, improving the evidence base, and helping us all to target resources more efficiently.

Alongside this we need to improve our systems for gathering and sharing intelligence on potential new concerns, both with industry and with other countries. And all this will still need to be backed up by ongoing independent checking and verification by the regulators and by local authorities.

. . . transparency in industry testing and assurance. . .