Toxicology Group Newsletter
Issue 2 2019

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Dear Readers,

Welcome to the Summer edition of the Toxicology Group's newsletter. It's jam-packed with details of meetings taking place before the year is out, plus meeting minutes from interesting meetings that have taken place Topics include plastics and regulation.

I was particularly pleased to read the article written by Dr Martin Rose, Dr Taichi Inui, Prof. Moira Dean and Prof. Jane Parker which aimed to de-bunk the myth that "natural" compounds are always safe e.g. puffer fish. Frankly, they aren't always safe, and in fact they and can be more toxic than synthetic compounds at lower doses. Unfortunately, what many consumers do not realise is that a compound which is synthetically made and identical to one which is naturally occurring is chemically identical and thus as safe in the same quantities.

Another observation I find frustrating is when consumers are told that a product contains "fewer chemicals" compared to a similar product. Consumers are misled to believe that the product is "safer" than the similar product and can mean that the consumer is more likely to purchase the product containing "fewer chemicals" based on this presumption. However, when I come across the phrase "fewer chemicals" in the supermarket I immediately wonder why a certain chemical compound may have been removed/reduced in quantity from a formula e.g. has the market price of the compound increased? Has the business decided that neither the company nor the consumer should subsidise this increase? Has the water content been altered? Is there just less "stuff" in the product? Am I getting less for my money? How are companies allowed get away with duping consumers? This is not right…someone needs to do something about this…oh look, tea bags, I need to buy some…

Enjoy the reading,

Anais Kahve
PhD Graduate, University of Exeter
Summer Newsletter Editor

Committee members

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Treasurer: David Hart (Nouryon)

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Keep in Touch

MyRSC is the RSC's social media platform. RSC Toxicology has a group on this site and we would encourage you all to sign up via the link below: http://my.rsc.org/groups/home/462.

This is an easy way for us to share information about the group and to have discussions. Our web pages will continue to host forms and more static content. We've now got 280 people signed up to the MyRSC group – but as we have nearly 500 Toxicology group members, there's still a way to go to get everyone on board!

In recognition that not everyone wants to use MyRSC, we have also established a **LinkedIn** group (https://www.linkedin.com/groups/12014086) and a **Twitter** account (@RSCToxGroup). Please do join in with the conversation!

Forthcoming meetings

Please take note of the following meetings and sign up early to avoid disappointment. Bursaries are available to any RSC Toxicology member for attendance at our meetings, subject to the usual conditions.

Indoor Air Quality Meeting

17th September 2019, Institute of Physics, London

A joint conference from the Institute of Physic's Environmental Physics Group and the RSC's Environmental Chemistry and Toxicology Groups.

With the average person spending up to 80-90% of their time indoors, prolonged human exposure to pollutants in indoor environments has become a health concern. However, our understanding of indoor air processes lags substantially behind that for outdoor air.

This one-day conference aims to address some of the current open questions in the field, exploring the relationship between indoor air quality and indoor-outdoor air exchange, building energy efficiency and design, occupant health as well as providing an overview of current research on the measurement and modelling of airborne species in indoor environments.

Registration deadline: 6th September 2019

Mutagenic Impurities

10th October 2019, Burlington House, London

The RSC Toxicology Group is supporting this one-day symposium organised by the Joint Pharmaceutical Analysis Group (JPAG), which will address issues and challenges associated with the implementation of ICH M7 guideline. It will provide an excellent opportunity for dialogue, discussion and debate with speakers - several of whom have been actively involved in shaping the guidance, and the peer group in an open forum. This is an excellent opportunity to learn from expert speakers who have been actively involved in the development of the guidance on these key topics. Delegates will be able to understand, interpret and translate into day-to-day practice the guidance relating to:

- Regulatory and pharmacopoeial interpretation
- Valsartan update

- Purging update from Mirabilis consortium
- State of the art approaches to analysis of MIs
- How do I present my MI data in a regulatory submission?

Registration deadline: TBD

Current Issues in Contaminated Land Risk Assessment

4th December 2019, Burlington House, London

Annual meeting, joint with the Society of Brownfield Risk Assessment (SoBRA), to update those in the field on new and emerging topics in contaminated land risk assessment.

Poster abstract deadline: 20th November
Registration deadline: 2nd December

Meeting Reports

Plastics, from Cradle to Grave and Resurrection

On 19th June 2019, the SCI's Environment, Health & Safety Group and RSC's Environmental Chemistry, Toxicology and Food Groups hosted 'Plastics, from Cradle to Grave and Resurrection' at SCI HQ, London.

[As reported on the SCI website, not necessarily reflective of RSC Toxicology views]

In a drive to reduce global plastic pollution, we are continuously developing plastic reduction strategies to create scalable solutions. The SCI Environment, Health & Safety Group's event on plastics highlighted recent, innovative breakthroughs in the field and society's growing involvement in sustainable activities, which is driven by impactful behaviour changes over the last couple of decades. These highlights were illustrated by three different speakers who have targeted where changes can be made to help solve the crisis.

1. Packaging and plastics

Stuart Foster, CEO of RECOUP, works to ensure that RECOUP delivers change through increased recycling and better use of plastic resources. Currently, RECOUP aims to facilitate a proactive approach to ensure that all parties, including designers, manufacturers, waste and resource management professionals and governments, are maximising the efficiency of plastic recycling. Today, the emerging 'cradle-to-

grave' concept aims to eliminate the negative environmental impact of plastic production and pollution and allows packaging material to be reused to create new packaging materials.

As sustainability concerns increase among the public, consumers desire sustainable packaging, such as packaging 'intelligence' that monitor product conditions. These are the biggest challenges facing packaging designers, in ensuring they meet consumers' expectations and reduce environmental impact.

RECOUP and the British Plastics Federation (BPF) have launched new guidelines to help packaging designers create plastic packing to help recycling plants identify, separate and recycle plastics easily. Big brands are especially encouraged to follow the guidelines to avoid their products ending up in landfill and instead move towards a circular economy. A circular economy aims to contribute to climate goals, preserve the world's resources, and reduce environmental damage from plastic. As companies build core competencies in circular design (e.g. by re-designing products) to facilitate product reuse, we are preserving the economic value of products and materials.

2. Healthcare and plastics

Ruth Stringer from Health Care Without Harm spoke about the concerning facts surrounding polyvinyl chloride (PVC) – one of the world's highest volume plastics – and its hazardous implications to human health. The common toxic additive in PVC medical devices is a plasticiser known as DEHP, which is part of a group of chemicals called phthalates that are extremely toxic. Unfortunately, due to manufacturer inaction and lack of legislation, many of these medical devices are still in use.

PVC has one of the most toxic manufacturing processes, emitting hundreds of hazardous residues. Epidemiological studies have identified that exposure to phthalates can trigger or cause fertility impairment, female reproductive tract disease, early puberty in girls, asthma, thyroid effects, and adverse effects on the lungs, liver and kidney.

"UK recycling companies have exported tons of plastic waste"

In the EU, phthalates are banned in children's toys, but the same compounds are still allowed to be used in medical devices in neonatal intensive care units. EU legislation requires the labelling of hazardous substances, but this form of protection is non-existent in some countries. UK recycling companies have exported tons of plastic waste in approximately 1,000 containers over recent years including plastics containing PVC, and consequently they have been recycled and reused in hospital settings with few regulations and controls.

Whilst PVC is recyclable it is not the solution as it releases toxic human carcinogens like dioxins. Hospitals need to be more aware of the plastics they use and ensure they do not end up in landfill. If plastics were properly labelled, hospitals can be better informed to make decisions based on the toxicity and recyclability of medical tools.

3. Behaviour change

Although positive action has been made on investment and policy to reach zero plastic waste, Sally Beken from Innovate UK posed an important question “how do we ensure delivery of change?”. While solving the technical and economic issues associated with plastics use would bring us closer to a solution, Beken argued that we need to ensure we understand human behaviour and attitudes towards plastic waste, including the cultural and societal nuances that play a significant role in governing how and how much people recycle.

As people are driven by intuitive processes including habit, social influence, emotion and heuristics, we have evolved to prioritise ‘fast and frugal’ processes that underpin most of our daily actions. This includes how we recycle. Something to take away from Beken’s discussion is our need to concentrate on implementing methods which will ‘nudge’ the everyday consumer to reduce and recycle which will drive more environmentally friendly behaviour among the population.

One of the challenges we are currently facing is the fact that recycling plastic packaging offers uncertainty to consumers as many are unsure which plastics can be recycled. Subsequently, material often enters the wrong waste stream, is discarded and becomes lost to the economy.

Changing behaviours on a large scale is extremely difficult, especially when the need for the consumer to move from intent to action is required. Developing and researching new methods to influence behaviour change is at the heart of many researchers and policymakers. What is clear though it that it is vital to always convey the positive environmental and social outcomes of any plastic strategy or infrastructure.

Tiffany Hionas, SCI

Naturals in Food

See original articles in New Food Magazine, parts 1 (April 2019) and 2

As consumers, we expect and demand that the food we consume should be safe and of good quality, but our perception of 'safe' and 'quality' is personal, and constantly evolving. Increasingly, the consumer is seeking organic produce, fewer food ingredients and additives (particularly in Europe with the removal of E numbers), proof of authenticity and provenance and natural and sustainable ingredients. But what does ‘natural’ mean, and is ‘natural’ always better; i.e. safer, more wholesome and more nutritious? Are there times when transparency is compromised in order to be able to describe food as natural?

What is a ‘natural’ ingredient?

The term ‘natural’ is defined as “existing in or derived from nature; not made or caused by humankind’, or ‘having had a minimum of processing or preservative treatment”. An image is conjured up in the mind of the consumer of green fields, the open rural environment, and often a sense of healthier and perhaps safer products.

The term ‘synthetic’, on the other hand, is defined as “made by chemical synthesis, to imitate a natural product” or “not genuine; insincere” and conjures up images of industrial chemical synthesis in an urban environment and an inferior product.

The distinction between these may be clear in the mind of the consumer and is clear in terms of chemistry when considering clothing materials, for example, where natural (cotton) and synthetic (nylon) are quite distinctly different in their chemical make-up. However, the distinction is blurred when it comes to food, as in many cases the natural and the synthetic versions are identical chemically.

“It is clear that the definition of ‘natural’ depends on your viewpoint – whether as consumers, as food regulators or as food chemists”

In terms of risk, if the molecules are identical, neither the method of production, nor the origin are relevant. But even the consumer perception of ‘natural’ does not always mean safe; most recognise that some fungi can be dangerous and are also aware of headlines such as “Two-star Michelin restaurant chef suspended over puffer fish poisoning”[1]. It is clear that the definition of ‘natural’ depends on your viewpoint – whether as consumers, as food regulators or as food chemists.

Consumer perception and consumer choice – heuristics

So how does the consumer develop their perception of natural, and how does this influence their purchase intent? All consumers (including regulators and food chemists) use heuristics to select at least some of their grocery products. The term heuristic refers to any approach to problem solving, learning, or discovery that employs a practical method, not guaranteed to be optimal, perfect, logical, or rational, but instead sufficient for reaching an immediate goal. Heuristics can be mental shortcuts that ease the cognitive load of making a decision. During food selection, for example in a supermarket, choice is not always based on logical or scientific reasoning. Rarely is there time to read every ingredient and make an analysis of whether or not purchases planned will result in a well-balanced, nutritious diet. Instead, the consumer is guided heuristically by food packaging, appearance such as colour, and simple terms that may be written on the packaging such as ‘wholesome’, ‘nutritious’, ‘fresh’ and ‘natural’. But what do these terms actually mean?

The term ‘natural’ is variously used and misused by sections of the food industry on labels and in advertisements. In a survey conducted in the USA[2], consumers were asked which of a list of foods and ingredients were ‘natural’. More than 60 per cent answered that corn and soya bean were natural, even though in the USA 92 percent and 94 percent of these products are genetically modified! Different flours (pea, wheat, sorghum) gave rise to different responses, possibly due to lack of familiarity. Products described by their chemical names were generally not considered natural, even when derived from natural sources.

In contrast to the situation in Europe, the term ‘natural’ has no legal definition within the USA so consumers from the EU and the USA have a different perception

of the term ‘natural’. These different perspectives were discussed by Rosin *et al* (2012)[3]. In the USA, the most frequent definition of natural was “no additives” whereas in Europe it was “lack of processing”. Interestingly, “origin in nature” was only used by about one third of respondents, although in France and the UK, this figure was much lower.

‘Natural’ food choices are generally important for consumers, although there are differences associated with country, gender and age of the consumer[4]. Many characteristics contribute to the concept of ‘natural’ and these can be assigned to six basic groups: psychological factors; situational factors; socio-cultural factors; extrinsic product characteristics; intrinsic product characteristics; and biological and physiological factors. Consumer beliefs also play a role, such as a belief that ‘wild types are more natural and better than varieties with genetic modifications’; or a belief that ‘natural foods have superior sensory characteristics such as taste or possess higher nutritive value’. These beliefs can be classed in two categories: (1) ideational beliefs, which are that natural entities are morally and/or aesthetically superior as they represent the original state or are untouched by human intervention and (2) instrumental beliefs, which are to do with functional or material superiority[5].

There is an underlying conflict in consumer preferences. Heuristics may lead to biased decisions: people may assume that they need to be less concerned about natural hazards than human-made hazards, or they may consider natural to be healthier when compared with synthetic product. They may view the qualitative characteristics of a hazard, rather than the relevant quantitative information. In general, the wish for unprocessed and natural foods needs to be balanced against the desire for foods with long shelf-lives that are convenient and quick to cook, and often these are incompatible.

Regulations

The regulatory bodies exist for the benefit of the consumer, to ensure that what is sold to the consumer is fit for purpose, which, in terms of food, requires it to be healthy, safe and nutritious. Another important aspect of food regulation is ensuring that food products are not portrayed in any way that might mislead the consumer. However, trying to harmonise the heuristics of the consumer with the logical approach of the scientist is a challenge for the regulatory bodies, and consequently food regulations do not always make sense. For example, there is a difference between a food colour and a colouring food. Food colours are regulated, whereas colouring foods are not, yet many are the same thing!

“The US Food and Drug Administration (FDA) discourages the food industry from using the word 'natural' on labels because of its ambiguity”

The flavouring regulations pose some interesting dichotomies. In the EU, flavourings are the subject of Regulation 1334/2008. Within these regulations, there are three guiding principles around the term ‘natural’. These are that the origin of the source material must be natural, the flavouring substance must have been identified in nature and the material should be produced by ‘traditional food preparation

processes' as listed in Annex II of the regulation. Furthermore, these substances must meet the criteria that (1) they do not pose a safety risk to the consumer, and (2) their use does not mislead the consumer. At first glance, this seems entirely reasonable, but as is often the case with regulations, there are grey areas and anomalies. Firstly, note that the category of 'artificial' was not included in this regulation, so any claim in the EU for "no artificial flavours" is meaningless and illegal. Within the US, there are different definitions and natural flavourings must be derived from natural starting materials and must also be listed as Generally Recognised as Safe (GRAS).

The US Food and Drug Administration (FDA) discourages the food industry from using the word 'natural' on labels because of its ambiguity. It accepts that it is a very complex term and have purposely decided not to define it on the grounds that, natural "may unjustifiably imply that a food is of superior quality or safety compared to other similar foods"[6].

In October 2018, the FDA announced that it was removing two 'natural' components of peppermint and sage (pulegone and thujone) from the list of approved flavourings, on the grounds that they are reported to be carcinogens, thus demonstrating their point that natural does not equal safe.

However, looking at vanillin we see the reverse, where vanillin which has been synthesised from petrochemical precursors (guaiacol and glyoxylic acid) needs to be labelled differently to the identical molecule that has been extracted from Vanilla planifolia. The legislation provides a clear distinction for consumers, although as chemists we see the same chemical just obtained from a different source. However, one key difference is that a compound from a synthetic source has undergone strict *in vitro* and *in vivo* toxicity tests, as required by EFSA, in order to be classed as flavouring substances. Another example would be that of smoke. Natural smoke contains polyaromatic hydrocarbons, which are known carcinogens, whereas these carcinogens can be removed (or omitted) from smoke flavourings. However, smoke flavourings cannot be labelled as natural.

Risk Assessment

The risk assessment process for food chemicals and ingredients is a scientific evaluation of the risk it poses to health as a function of both toxicity and exposure. Risk management uses the risk assessment and combines the evidence with social, political and economic factors to derive limits. A recent ILSI (International Life Sciences Institute) workshop discussed advantages and disadvantages of both hazard- and risk-based approaches to ensuring food safety and concluded that the value of risk-based approaches is becoming increasingly recognised[2]. Whether or not a compound is derived from natural or synthetic processes is irrelevant to risk assessment, but not to risk perception and therefore risk management.

"Formaldehyde is found at highly variable concentrations in food"

Taking formaldehyde as an example: this is classified as a known human carcinogen both in the EU and the USA. The main concern is inhalation and respiratory cancers, but it is also associated with leukaemia so there is no dispute

that this is a dangerous compound. However, formaldehyde is known to occur naturally and is an essential intermediate in cellular metabolism in mammals and humans. Formaldehyde is found at highly variable concentrations in food, ranging from < 0. 1mg/kg in milk to > 200 mg/kg in fish, and calculations show that oral exposure to formaldehyde from food would not normally exceed 100 mg/kg food per person per day, i.e. 1. 8 mg/kg bw (body weight) per day for a 70 kg person[3]. It is known that methanol is metabolised to produce formaldehyde, and that methanol is formed from aspartame by enzymes in the digestive system; thus consumption of the sweetener, aspartame, leads to an increased exposure to formaldehyde. However, despite this association with a known carcinogen, it does not make sense to restrict the use of aspartame on this basis since exposure from using aspartame, even with large amounts, results in far lower levels of methanol and formaldehyde than are found from other dietary sources. In fact, the maximum potential change in cellular levels from aspartame at its acceptable daily intake (ADI) is less than the normal variability in these cellular levels. Many of the most toxic compounds that humans are exposed to from their diet come from natural sources and can be considered as natural compounds. Although the risk assessment process is the same regardless of the production process, there are some challenges that tend to be associated with 'natural' ingredients. Synthetic, or 'artificial', ingredients are often well-defined materials and are usually of high chemical purity. Specifications can be tight, and toxicology studies are conducted on defined materials. Natural ingredients, on the other hand, are generally poorly defined materials, with extracts of varying purity and specifications can be very loose. There can be seasonal or geographical variations that are inherent in the biological nature of the products from which they are derived. Often, it is not certain what was tested or the purity of the product. 'Regulatory creep' can be a problem with the range of quantities used and applications to which natural ingredients are used.

Most traditionally used foods have not been subject to systematic toxicology study but are considered safe to consume as they have a long history of use and lack any evidence of harm. This 'history of safe use' concept has originally been developed for assessment of novel foods and foods derived from genetically modified organisms[4] as a benchmark for comparative safety assessment. To move away from subjective decision making, a multi-criteria decision analysis model was subsequently developed as a comprehensive comparative approach to assess the safety of natural materials[5]. Using all available evidence (concerning history of use and evidence for concern of the natural material or its components), safety decisions can be made more objectively and transparently.

Drivers and challenges when converting to natural Flavours

Today's consumer demands both natural and sustainable food, so we must question whether they can both be achieved together. Let's consider the world's most popular flavour, vanilla. Madagascar is responsible for 80 percent of the world's vanilla, but in 2017, it faced a devastating cyclone. This saw the price of high quality Madagascan cured vanilla beans overtaking the price of silver and it currently sits at around US$550 per kg (up from US$10 per kg five years ago). An increase in demand, with a decrease in supply and an expensive crop that supports over 80,000 farmers has led to exploitation, corruption and poor-quality produce.

One solution to supplementing the variable, inadequate and expensive supply of extracts of vanilla planifolia is to produce vanillin, the main component of vanilla

extract, from other sources. Vanillin can be produced via chemical synthesis, but this is very clearly not natural. However, regulations allow vanillin that has been produced via physical, enzymatic or microbiological processes (which conform to traditional food preparation methods) to be labelled as natural. In the US, natural vanillin can be generated from clove oil or pine tree using eugenol or coniferyl alcohol as starting materials respectively. The EU regulations, perhaps recognising that this may mislead the consumer, do not class this as natural, but vanillin derived from rice bran or corn sugar can be classified as natural in the EU. Thus, by using other natural flavouring ingredients, as defined by EC/1334/2008, it is possible to make a more cost-effective natural vanilla flavouring that still contains vanilla but also contains naturally sourced and isolated aroma molecules such as Vanillin ex Ferulic Acid Natural to 'make the vanilla go further.'

"Colours from natural sources are more expensive than their synthetic alternatives"

Colours

Colour influences purchasing decisions, signals the quality and safety of the food and influences flavour perception. The classification of natural colours is less regulated than for flavourings, but the Natural Food Colours Association (NATCOL) has defined a classification of natural colours related to 'degree of naturality'. Again, food regulations are not aligned with consumer demand, nor are they aligned globally. Spirulina extract that comes from a blue-green algae is classified as an 'additive' in the US, but a 'food' in the EU, while pigments like chlorophyll are allowed as a colour additive in the EU, but not in US. The major challenges, particularly when converting to natural colours, are that natural colours are more susceptible to interactions with other components of the food matrix, inorganic salts, light, oxygen, processing and especially pH. Anthocyanins change from red to blue over a pH range of 3-6, and heat treatment or the addition of vitamins can cause browning. Colours from natural sources are more expensive than their synthetic alternatives, but companies are focusing on minimising the agricultural footprint and optimising extraction procedures, formulation and applications.

Pet care products

As the use of the term 'natural' has expanded in human food, so it has been adopted and applied to the world of pet food too – with one significant difference. In the USA and EU, the term 'natural' is defined either by regulation or Code of Practice. In practice, at least in Europe, few, if any pet foods are likely to be able to describe themselves as natural but many can, and do, claim to be made with natural ingredients. Of course, this doesn't necessarily mean that they are better than foods not making such a claim, since main meal pet foods must contain all the daily nutrients that a pet needs; so 'natural' isn't necessarily better in nutrition terms. Neither does it mean the products are safer – any European pet food containing animal products must be processed to minimum legal standards to ensure that they are safe for owners to handle and pets to consume. Increasingly, 'natural' has become shorthand for a product sector within pet food, that encompasses other terms and claims, such as organic; exclusion diets (i.e. made without wheat);

ancestral products and ancient grains. This approach, together with advances in innovation and technology, such as the introduction of chilled pet foods in Europe, offers both challenge and opportunity to manufacturers wishing to expand into this growing area.

Conclusions

Terms such as 'natural' have an increasing importance to consumers and therefore to the food industry. This is reflected not only in terms of product development and marketing but is also a key factor for innovative food technologies. Whilst 'natural' is important for the consumer, it is part of a balance of conflicting interests. The consumer wants products that are unprocessed and natural – but at the same time are convenient, affordable and quick to cook. This presents a challenge for industry to implement production processes, ingredients, packaging and marketing activities so that the product may be perceived as natural, with similarities to traditional food, yet with long shelf life and convenience

Dr Martin Rose, Dr Taichi Inui, Prof. Moira Dean and Prof. Jane Parker
(RSC Toxicology and Food groups)

IGHRC Chemical Regulations Meeting

On 27th February 2019 a joint meeting was held between the Interdepartmental Group on Hazards and Risks of Chemicals (IGHRC) and the RSC's Toxicology Group, Speciality Chemicals Sector and the RSC's Environment & Regulation Collective at Burlington House.

Presentations from the event available at the above weblink.

The aim of the event was to increase awareness and understanding of worldwide regulatory regimes and guidelines for chemical hazard and human and environmental risk assessment across markets, to inform best practice and policy-decision making in the post EU-Exit era.

The workshop helped the audiences to gain an understanding of chemical regulation in UK, US, EU and South Korea. The nine speakers, who came from a wide range of sectors, presented an outline of the possible impacts of differing approaches to chemical regulation for UK government departments and agencies, industry regulatory professionals and business leaders. Despite the uncertainty associated with the UK's exit of the EU, the workshop was very informative and gave participants (1) a better understanding regarding possible changes to the UK's chemical regulatory system, and (2) an opportunity to collectively discuss where the regulatory system would/could/should go after EU-exit.

Dr Kay Williams, Head of EU and International Chemicals Unit at Defra, explained (1) the UK's strategy for chemicals following a 25-year plan to improve the environment, (2) the differences between a no-deal-Brexit, the Withdrawal Agreement and implementation period scenarios, and (3) international chemical regulatory projects, including Defra's recent collaborations with other international bodies such as Strategic Approach to International Chemicals Management

(SAICM), the OECD and the Japanese government. Dr Williams subsequently explained that the direction of UK's chemical regulations after the EU-exit would still be close to the EU's, yet the UK government is keen to take a leading role in the international chemical regulation system.

Dave Bench, Chemicals Regulation Division, Health & Safety Executive, talked about the Joint HSE/Defra EU Exit Chemical Programme. The role of each of both the HSE and Defra was clearly shown: HSE policy lead - CLP, PIC, BPR; Defra policy lead - REACH, PPP, MRLs, Detergents, POPs, and Mercury. His explanation about what is happening with CLP, REACH, BPR/PPP in no deal scenario was very informative. Dave subsequently explained that during the implementation period, any new EU regulation will not need to be followed. Additionally, the UK government can stay in line with existing EU regulation. Or it can choose to go in a different direction.

Karyn Schmidt, ACC, USA, explained the definitions of new chemicals, and existing chemicals and the toxic substances control act (TSCA)'s new chemical review. Karyn's presentation clearly stated the issues of TSCA and introduced the Lautenberg Chemical Safety Act (LCSA) and the inventory reset.

Yang Junyoung, Chemtopia, South Korea, talked about the introduction to revised K-REACH and sub-ordinance. Craig Deegan, CS Regulatory, talked about the use of internet search engines for filling the gap in scientific research to strengthen the regulatory decision-making processes. Craig mentioned the Japan NITE data base, which although is a good search engine, it is only available in Japanese and thus requires translation. However, considering the enormous volume of high-quality scientific data uploaded by Japanese institutes, this platform might be worth utilising.

Zhanyun Wang, ETH Zurich, Switzerland talked about the United Nation's strategic approach to international chemicals management (SAICM) and the need for a strengthened science–policy interface. Tim Harris, Department for International Trade, explained the UK government's perspectives on the future chemical international trade policies, barriers to trade, and priority markets. Jennifer Butcher, Chemical Industries Association (CIA), talked about industry's perspectives regarding current international regulations. The final speaker was Miriam Jacobs, Public Health England (PHE), UK. Miriam presented perspectives of the OECD test guidelines and novel developments and perspectives from the UK. After the all 9 presentations were finished, a facilitated discussion was opened.

All the presentations and the facilitated discussion were very informative and gave participants a deeper understanding about the complex relationship between the EU-exit and the chemical regulatory system. The impact of the UK's exit from the EU and the uncertainty towards the governmental bodies and public sectors in UK will be immense.

Dr Yukari Ishikawa

BTS Congress 2019

The 40th annual British Toxicology Society (BTS) congress, joint with the UK Environmental Mutagen Society (UKEMS), took place this year at Robinson College, Cambridge.

This year's congress had an emphasis on genotoxicity and *in silico* methodology. The first day of the congress began with the continuing education programme (CEP) titled "Genotoxicity Testing in the 21st Century – a Paradigm Shift!". Dr Laura Brierley's presentation titled "*In silico* Approaches to Genotoxicity Testing" highlighted the use and best practices for the development of quantitative structure-activity relationship (QSAR) *in silico* models and read-across for genotoxicity prediction.

Dr Stefan Platz delivered the Plenary Lecture titled "Impact of Artificial Intelligence in Understanding Toxicology insights". Dr Platz's talk highlighted the vast amount of data that can be generated for developmental compounds in drug discovery and how tools such as artificial intelligence, machine and deep learning can aid discovery to predict safety and toxicology data for future drug compounds.

"Identifying which cannabinoid a patient has been exposed to is a growing challenge"

The congress spilt into parallel sessions throughout the three days. The first symposium I chose to attend was called "Developmental Toxicology: New paradigms" which discussed issues and challenges in developmental and reproductive toxicology (DART). The second session I attended was the MRC ITTP Biannual symposium. Dr Sally Bradberry gave an excellent talk titled "The Clinical Toxicology of Synthetic Cannabinoids". Dr Bradberry discussed the challenges that healthcare professionals face in Accident & Emergency, managing patients intoxicated with synthetic cannabinoids commonly referred to as 'spice'. Identifying which cannabinoid a patient has been exposed to is a growing challenge due to the rapidly changing composition of spice products whereby new generations of the drugs are being produced in very short periods of time. The first day closed with a BBQ and drinks reception in the picturesque grounds of the college, allowing time to network and enjoy the gardens with the other delegates.

The second day kicked off with split symposia. The talk from PhD student Carol De Santis discussing *in vitro* systems for investigating cardiotoxicity included a fascinating video of cardiac cells beating *in vitro*. This session was followed by the Early Career Investigator prize lecture delivered by Dr Martin Clift. Dr Clift presented a talk on his research career to date covering the toxicity of nanoparticles and fibres in the lungs. In addition, he highlighted the challenges of utilising *in vitro* models for the study of lung toxicity and the advances of multiple cell co-culture models and monoculture systems with dynamic movement and fluid-flow for studying lung toxicity.

The subsequent two sessions I attended were both a collection of short 15-minute presentations, the RSC/BTS- and UKEMS-selected short oral communication symposia. Both sessions emphasised the diverse areas of research that toxicologists are engaged in. The BTS: Barnes Prize Lecture was awarded to Professor Andy Smith. Prof. Smith's lecture titled "Toxicology Concepts From Applied and Fundamental Studies of Iron and Haem Biology" covered his long career in toxicology. His entertaining lecture was, for me, the highlight of the congress and he thoroughly deserved the award. The second day ended with the congress dinner hosted at the Queens College which contains the famous Mathematical Bridge crossing the River Cam. During the dinner the awards for the oral and poster presentations from the BTS, UKEMS and the *in vitro* toxicology society (IVTS) were presented.

On the final day, I attended two symposia on the use and selection of animals for toxicology studies titled "Alternative Approaches to Toxicology: What is the Current View on the Future of Animal Testing?" and "Justification for Species Selection for Pharmaceutical Toxicity Studies". Both sections focused on the future use of animal models in line with the NC3R guidelines to replace, reduce and refine the use of animals for scientific purposes. Dr Benedetta Sallustio delivered the ASPECT Lecture titled "Renal Transplantation: Transporters, Genetics and Immunosuppressant Nephrotoxicity" covering the challenging balance that must be achieved when using immunosuppressants to avoid rejection of the transplanted organ and nephrotoxicity. The ASPECT Lecture was followed by a workshop titled "Toxicology Education in the UK – Future Scope?" which was an open brainstorming session. There is currently a shortage of trained toxicologists in the UK and the aim of the session was to discuss ways that members of the BTS and related societies can contribute to the development of future generations of toxicologists.

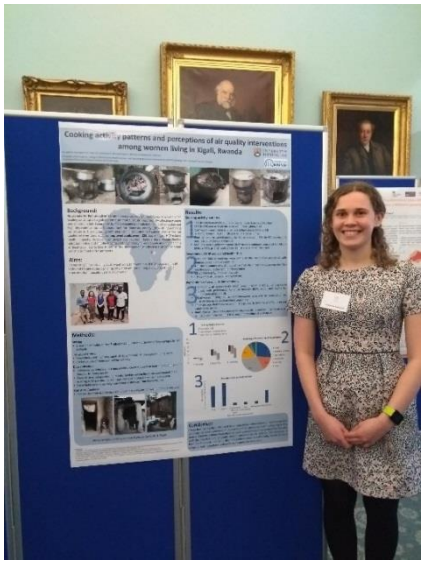
In addition to the varied programme of presentations by expert speakers, the congress provided many opportunities for early career delegates to contribute scientifically. I was able to present my current research on developing structure-property relationship models for the prediction of acyl glucuronide degradation along with sixty-three other posters from students and early career researchers covering a board range of research including nanoparticle toxicity, air pollution and the toxicity of electronic cigarettes. It was interesting to discover the varied areas of toxicology that researchers at a similar stage to myself were investigating.

I found the diverse range of presentations and workshops from perspectives including pharmaceutical, occupational and clinical toxicology very interesting and enjoyable, and I intend to apply what I have learnt to my current research. I recommend the next BTS congress in Cardiff (April 2020) to all toxicologists especially early career researchers due to the mixture of subjects discussed and the opportunities to present and network.

Dr Peter Bradshaw
Post-Doctoral Research Associate
Imperial College London

Poster Prizes at UK/Ireland Epidemiology and Exposure Science

The UK & Ireland Occupational & Environmental Epidemiology and Exposure Science meetings took place on 1st and 2nd April 2019 in Edinburgh. Congratulations to Catherine Campbell and Jake Launder for winning the poster prizes! Both posters can be found in the following two pages.



Catherine alongside her poster.

Cooking activity patterns and perceptions of air quality interventions among women living in Kigali, Rwanda

Campbell C, Bartington S.E, Pope F.D, Tumwizere P, Umwanyirigire C, Abimana P, Thomas GN, Kabera T.

University of Birmingham, College of Medical and Dental Sciences, Institute of Applied Health Research, School of Geography, Earth and Environmental Sciences
University of Rwanda, College of Science and Technology

Background:

Household Air Pollution (HAP) from biomass cooking with traditional stoves is the 8th leading contributor to global premature mortality[1], disproportionally affecting women and children in Sub-Saharan Africa.[2] An expanding population, rapid urbanisation and high dependence upon biomass fuel for domestic energy (97% of households) contribute to the increasing HAP-related health burden in Rwanda[3], East Africa. Air quality interventions such as **improved cookstoves (ICS)** may mitigate HAP-related health impacts, however, contextual socio-cultural factors have widely limited adoption in low and middle income settings.[4] Policymakers require an understanding of local cooking practices to inform the development of effective HAP interventions which also meet end-user needs.

Aims:

To report: (1) local cooking activity patterns, (2) awareness of HAP associated health risks and (3) perceptions of air quality interventions among charcoal cooking fuel users in urban households in Kigali, Rwanda.

Methods:

Setting

- Urban households across 7 villages within Muhima Sector of Nyarugenge District in Kigali

Inclusion Criteria

- Households with women aged 18-55 years with at least one child < 5 years
- Exclusive use of biomass fuel for cooking

Data collection

- Convenience sample of 40 households selected based on household demographic data for Muhima Sector
- Semi-structured questionnaire informed by recent literature and modelled on existing HAP questionnaires produced by the World Health Organisation
- Local fieldworkers verbally translated responses from Kinyarwanda

Statistical Analyses

- Simple descriptive statistics and univariate analyses (36 women in final analysis)

Above images: cooking areas in Nyarugenge District, Kigali.

References

1. Stanaway, J et al. Global, regional, and national comparative risk assessment of 84 behavioural, environmental and occupational, and metabolic risks or clusters of risks, 1990-2016: a systematic analysis for the Global Burden of Disease Study 2016. Lancet 2017; 390: 1345-1422
2. World Health Organization. Household air pollution and health. Available at: http://www.who.int/mediacentre/factsheets/fs292/en/
3. Africa Energy Services Group Ltd. Biomass use survey in urban and rural areas in Rwanda. Energy Water and Sanitation Authority. 2012
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Results:

Cooking activity patterns

1

- 94% (n=34) households used charcoal as the exclusive cooking fuel
- 81% (n=29) also used plastic as an additional lighting fuel
- Cost was the main cited determinant of fuel choice (92%, n=33)
- 97% (35) women used a single-pot metal charcoal stove
- Cooking patterns varied among the households with 53% (n=19) cooking one meal each day (range 1-3 meals)
- Mothers were significantly more likely to cook outdoors compared to indoors (64% vs 36%, p<0.05) and 25% (n=9) had a separate kitchen area

Awareness of HAP associated health risks

2

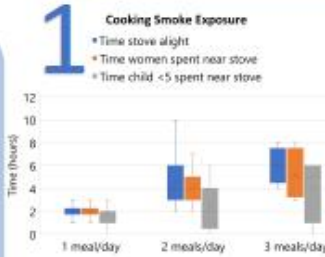
- Less than 50% of mothers were aware of the health risks associated with biomass cooking smoke exposure
- 4 of the 5 women who did not allow their child near the stove reported this was because they feared them being burnt
- 65% children (<5y) reported a cough
- 81% women experienced eye symptoms

Perceptions of air quality interventions

3

- The majority of women (64%, n=23) were unaware of ICS but all expressed interest, with preferences for stove mobility (89%, n=32) and facility for multiple pans (53%, n=19)
- 1/3 of women highlighted lack of homeownership as a barrier restricting their ability to improve their household ventilation
- The main reported concerns about using gas fuel included cost (44%, n=16) and safety (50%, n=18)
- Burn injuries, cleanliness, improved stove durability and improved taste were all reasons cited for wanting to change from traditional cookstoves

1



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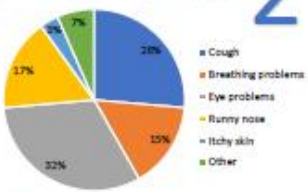

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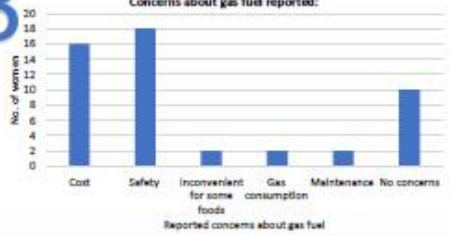

Conclusion:

These findings highlight the need for an educational intervention or health promotion campaign to raise awareness of the harms of HAP among women in urban Kigali. This data will inform a future household air quality monitoring study planned for this area and the development of public health interventions to reduce HAP exposure in Rwanda. It is clear that air quality interventions must be sufficiently flexible to suit a range of cooking patterns and preferred features for end-users.

How reliable are low-cost air quality monitors? Implications for exposure science

Jake D. Launder[1*], Samantha Hall[2], Andrew Thorpe[2], David A. Polya[1], and Jackie Morton[2]

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1. Rationale

Particulate matter is a leading contributor to global morbidity and mortality[1]. Despite this, traditional methods of assessing exposure to $PM_{2.5}$ can be non-standardised, often are non-personal, and likely are not optimal[2].

As a result, low-cost air quality monitors (LCMs) capable of measuring $PM_{2.5}$ are increasingly being used by both professional and citizen scientists as an alternative means of exposure assessment[3]. However, reviews of recent research have cast doubt over their reliability as a tool for $PM_{2.5}$ exposure assessment[4,5].

2. Aims and objectives

This work aims to test the reliability of LCMs capable of $PM_{2.5}$ exposure assessment.

Objectives:

1) To select suitable LCMs.
2) To test the reliability of each LCM experimentally in a wind tunnel, by simulating personal exposure assessment.
3) To assess the reliability of each LCM quantitatively, by means of their accuracy and bias, and qualitatively, by appraising their measurement repeatability.

3. Methods

Objective 1

LCMs were selected for reliability testing based upon their functionality, cost and wearability.

Objective 2

A Spherigiass 7010 test dust was used for reliability testing. It was fed into the wind tunnel using a Palas Rolling Brush Generator 1000, which ran at five feed belt speeds. Selected LCMs and a reference instrument (Model 3321 Aerodynamic Particle Sizer, TSI Inc.) sampled the test dust concentration for ~10 minutes at each feed belt speed. The experimental set-up in the sampling zone of the wind tunnel is shown in **Figure 1**. Testing was repeated three times at two wind speeds – 0.5 m s^{-1} and 2.0 m s^{-1}.

Figure 1 Composite image of the experimental set-up in the sampling zone of the wind tunnel during reliability testing. Aerosol travelled across the image from left to right.

Objective 3

Data processing and subsequent statistical analyses were carried out in Microsoft Excel 2010 and R (v. 3.4.1), respectively, and in accordance with the methods used by Sousan *et al.*[6].

4. Results

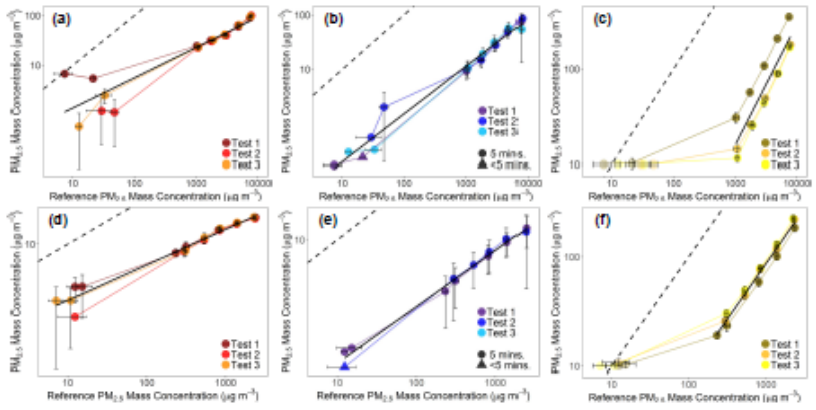

Figure 2 $PM_{2.5}$ mass concentrations measured by low-cost air quality monitors (LCMs) plotted against those measured by the reference instrument at two wind speeds – 0.5 m s^{-1} (**a - c**) and 2.0 m s^{-1} (**d - f**). (**a, d**) = LCM A. (**b, e**) = LCM B. (**c, f**) = LCM C. The dashed line represents $y = x$. All error bars symbolise one standard deviation.

Table 1 Accuracy and bias of low-cost air quality monitors (LCMs) A - C across all ranges of $PM_{2.5}$ mass concentration at each of two wind speeds – 0.5 m s^{-1} and 2.0 m s^{-1}. * = linear regression used for reference $PM_{2.5}$ mass concentrations >100 μg m^{-3} only.

LCM	Data Pairs	Regression Coefficient, *m* (± SE)	Intercept, *c* (± SE) (μg m^{-3})	Pearson Correlation Coefficient, *r*	Coefficient of Determination, R^2	Mean Bias (%)
0.5 m s^{-1}						
A	21	0.012 (± 0.00032)	5.9 (± 1.2)	0.99	0.99	-92
B	21	0.0096 (± 0.00047)	0.40 (± 1.8)	0.98	0.96	-99
C*	15	0.032 (± 0.0059)	-22 (± 26)	0.84	0.67	-98
2.0 m s^{-1}						
A	20	0.016 (± 0.00084)	3.1 (± 0.94)	0.98	0.95	-97
B	13	0.0062 (± 0.00025)	0.34 (± 0.28)	0.99	0.98	-99
C*	15	0.089 (± 0.0044)	-2.4 (± 5.7)	0.98	0.97	-91

5. Conclusions

- At both wind speeds, LCMs A and B linearly ($r \sim 1$) and systematically underestimated ($m << 1$, mean bias = -92 - -99 %) $PM_{2.5}$ mass concentrations in the wind tunnel, relative to the reference instrument. Moreover, their measurement repeatability was generally relatively more variable at lower mass concentrations than at higher mass concentrations.
- At both wind speeds, LCM C linearly ($r \sim 1$) and systematically underestimated ($m << 1$, mean bias = -91 - -98 %) $PM_{2.5}$ mass concentrations in the wind tunnel that were above background levels only, relative to the reference instrument. In addition, its measurement repeatability differed across both wind speed and $PM_{2.5}$ mass concentration. Measurement repeatability was relatively more consistent at higher wind speeds and background mass concentrations, respectively.

6. Implications for exposure science

- LCMs A - C, some of which are commercially available, are not out-of-the-box instruments. Hence, they are not immediately and reliably accurate.
- Inaccurate but linear responses can be corrected by means of calibration[6]. However, calibrations need to be use-specific because they depend upon factors such as time, both particle shape and composition, and location. Resultantly, inaccuracies associated with using LCMs to measure $PM_{2.5}$ become a major problem.
- The implications for exposure science above are in agreement with recent research[6,7,8], that use-specific calibration is necessary in order to ensure the reliability of LCMs measuring $PM_{2.5}$ as part of exposure assessments.

7. References

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Acknowledgements

This work was carried out during a Natural Environment Research Council (NERC) EAO Doctoral Training Partnership (NE/L002469/1) CASE (Health and Safety Executive) PhD studentship. The funding and support from NERC and the Health and Safety Executive (HSE) is gratefully acknowledged. JDL would also like to thank David Green and Colin Cregge (Air Monitors Ltd.) for their advice on the experimental design of this work. Furthermore, JDL thanks Paul Roberts (formerly of HSE) for their invaluable help and guidance during testing. Lastly, JDL thanks Dr. James Allan (The University of Manchester) for their advice on processing the reference instrument data.

Faces of Toxicology

For those of you who have not yet checked out these videos, a playlist can be found here. This video series aims to showcase the variety of careers available in toxicology. The series begins with an animated overview of toxicology as a science followed by individual toxicologists talking about their work. The Toxicology Group Committee is working to add further videos, so if you are interested in being a "face" of toxicology, please get in touch.

The RSC presented the Toxicology Group Committee an award for their work on this video collection! The prize was awarded for the Group's work for highlighting the diversity of scientists and career opportunities in the toxicology community. Below is Kate Jones collecting the award.

Other News

Toxicology Research has a new home

The RSC has announced the transfer of the journal Toxicology Research from the RSC's journals portfolio to the Oxford University Press (OUP). Read more via the link below:

https://www.rsc.org/news-events/articles/2019/jul/tox-res-moves-to-oup/

The RSC Toxicology Group is supporting this one-day event organised by CIRIA

15th October 2019, London

The Construction Industry Research and Information Association (CIRIA) is a neutral, independent, not-for-profit organisation. They facilitate a range of collaborative activities that help improve the construction industry.

This event will discuss why construction professionals in the UK should pay more attention to perfluorinated alkylated substances (PFAS) and how to assess and manage that risk. Read more via the link below:

https://www.ciria.org/CIRIA/Navigation/Events/Event_Display.aspx?EventKey=E19304