Agri-tech
New breeding techniques

ALSO
- B2B web platform for trading surpluses
- Agri-EPI Centre
- Biogas fuel
- Micro-scale AD
- Food reformulation
- Choking hazards
- Miniaturised food sensor
- Food labelling
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VOLUME 31 ISSUE 3

EDITOR Melanie Brown
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Contents

14 Breeding crops for the future: Toni Morgan identifies the potential benefits that could arise from the use of New Breeding Techniques for crops in the UK

18 Waste not want not: Pascale Martin describes Agronomy’s ambition to facilitate the direct trade of surplus fresh produce in the UK via a B2B web platform.

20 Agri-EPI Centre: Vickie Cooper and Rob Merrall explain the objectives of the new Agricultural Engineering Precision Innovation Centre.

24 Fuel for thought: Richard Guetterbeck and Andrew Winspredit the benefits of using biomethane generated on-site from food and drink process residues as a fuel for HGVs.

28 Giant LEAP for micro-scale AD: Helen Theaker, Mark Walker and Rokiah Yaman explore a circular organic model that could yield social, environmental and economic benefits.

32 The history of food reformulation: Helen Munday and Lindsey Bagley consider the contribution of food science to nutrition through reformulation of foods in the last 50 years.

40 Safer sweets: Michael Walker and Kirstin Gray discuss checking risks from jelly confectionary and associated technical appeals to the Government Chemist.

44 Food labelling beyond EU borders: Sarah Howarth looks at some of the challenges ahead in overseas trading of food and drink products with a focus on the CODEX food labelling standards.

48 Sensors break out of the lab: Isabel Hoffman, Mark Biorus, Behzadan Danesh and Zoltan Kovacs describe a new, miniaturised food sensor able to detect compounds, such as melamine, in food at a molecular level.

Regulars

4 Editorial

4 International and Home News

7 IFST News

52 Careers and training in the food and drink sector

56 Book reviews
Food regulation is changing

The FSA Chairman, Heather Hancock, has published new plans to change food regulation[3]. The document, ‘Regulating Our Future – Why food regulation needs change and how we are going to do it’, sets out proposals for start-up businesses in the agriculture and horticulture sectors. The UK fruit and vegetable supply chain generates substantial wastage of edible apples as a result of supermarket requirements and consumer demand for high quality products. Two new UK start-ups are aiming to facilitate the direct trade of surplus fresh produce via web platforms to improve the efficiency of the supply chain both in the UK (p18) and for subsistence farmers in developing countries, such as those in sub-Saharan Africa (p5). Another UK start-up has developed a unique aerial soil sensor that can provide a detailed map of moisture in the soil – even through vegetation – for a whole farm in minutes (p5). Smart water usage will be increasingly important as conditions in many parts of the world, including the south east of England, become drier.

New Breeding Techniques (innovative plant breeding using gene editing, gene transfer or changing gene activity) offer exciting potential to generate innovative plant varieties able to address the challenges facing food supply, such as climate change and spread of pests and plant diseases (p14). The current controversy about whether these techniques involve GM is slowing progress in this field within the EU.

UK Government support for the agritech sector has established three new centres for Agricultural Innovation. One of these, the Agricultural Engineering Precinct (AEP) at Agri-Epi Centre, is supporting innovation in precision agriculture by providing world-class laboratory facilities, IT hardware and software, and access to a network of farms for developing and testing new agricultural technology and products (p20).

Innovative use of bioenergy from anaerobic digestion of food and agricultural residues, such as for powering delivery trucks (p24), is also offering new opportunities for enhancing sustainability and promoting the circular economy (p28).

FSA believes that the existing regulatory model for food is no longer fit for purpose. By 2020, it plans to have introduced a new, flexible regulatory model for food. The paper details the changes the FSA wants to make to build a modern, risk-based, proportionate, robust and efficient regulatory system. The key changes proposed are:

• An enhanced system of registration for businesses, which will mean securing better information on all businesses in the food chain. Knowing more about a business will enable better judgments to be made about regulating it. The aim is to create a hostile environment for those businesses that don’t proactively register.

• Segmenting businesses in a better way using a range of risk indicators based on wider information about the business, including the information relating to point of registration and from other sources. There will be more onus on businesses to prove that they are doing the right thing. Depending on how robust the information that businesses share is, the FSA will use this to quickly identify those whose past performance, this FSA will set the frequency and type of inspection. The key is to enable businesses with a good history of compliance to trade on the same level as those that present the greatest risk to public health.

The FSA remains committed to its Food hygiene Rating Scheme. It will continue to ensure the scheme is sustainable and that display legislation becomes mandatory in England as it is in Wales and Northern Ireland.

The Institute for Food Security at Queen’s University Belfast will lead one of the world’s largest food safety projects across Europe and China[5]. The European Horizon 2020 programme and the Chinese Ministry of Science and Technology (MOST) programme have awarded €10 million towards an EU-China partnership to improve food safety and tackle food fraud. The EU-China-Safe project brings together 10 key players in the food industry, research organisations and governments across two of the world’s largest trading areas, including 15 partners in the EU and China. It aims to innovate food fraud and increase food safety by focusing on improving food safety regulation and food inspection as well as increasing access to information across both continents. State-of-the-art technologies, including a virtual laboratory, will create a unique space to share and demonstrate best practice. The aim is to facilitate the expansion of EU-China trade.

Reported instances of food fraud are on the increase globally. Recent food fraud incidents have had devastating consequences. Horse meat was labelled and sold as beef in Europe in 2013, contaminated with horse muscle (known as gullet oil), which had been recycled from waste oil that had been rendered as restaurant fryers, grease traps, slaughterhouse waste and sewage, was sold in China in 2014.

The GROW Judges’ Award went to Farmingen, which is developing a digital platform that enables direct trading between farmers and buyers through SMS, smartphone application and an integrated voice system. The platform calculates aggregated crop prices that are geographically relevant to the user, allowing farmers to make informed decisions about when and where to sell for the best price. The platform also streamlines the management and payment process using SMS and mobile money and enables farmers without smartphones to access essential features.

The SoilSense monitor can be mounted on a drone and provides an accurate MoistureMap visualisation of the field in minutes. This offers the potential for smart irrigation controlled by actual data.

Typically soil moisture is measured using sensors placed directly in the field. These are time-consuming to install and only give an accurate measure of a single spot in the field. Larger fields require tens or hundreds of these sensors installed, which is impractical. An alternative is an aerial sensor but again these are regulated with the restrictive use of passive radioactivity, which is sensitive to adverse weather conditions and prone to interference.

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Smallholders grow 50% of the world’s food and 40% of global food production relies on irrigation. Smart water usage is essential for many parts of the world, including the dry east of Africa, so being able to adjust water usage based on soil moisture content is a major breakthrough.

The company is looking to work with developers of drone and smart irrigation technology as the sensor can add value to other products or be offered as part of a service.

Winners of AgriTech East’s 2017 GROW agri-tech business plan competition, aimed at stimulating entrepreneurship in the sector, were announced in June[4].

Innovative use of bioenergy from anaerobic digestion of food and agricultural residues, such as for powering delivery trucks (p24), is also offering new opportunities for enhancing sustainability and promoting the circular economy (p28).

The EU and China tackle food fraud together

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### Containing norovirus

The FSA has published a report, ‘Food handlers and Norovirus transmission (FS10113)’, on research carried out by Ipsos MORI. The study aimed to help stop the ‘winter vomiting bug’ norovirus from spreading by understanding and improving food handler behaviours. A literature review identified five key strategies for controlling norovirus:

1. Personal hygiene
2. Food handling
3. Washing and cooking food
4. Surface and uniform cleaning
5. Fitness to work

Visits to food catering establishments involved in-depth interviews, surveys and structured environmental and behavioural observations. The strongest evidence for risk of norovirus spreading was:

- inadequate hand washing not washing hands before gloving
- using bare hands when preparing food
- not regularly changing gloves
- food handlers instead of trained staff cleaning areas where people vomited

Data analysis and behavioural theories were used to rank behaviours that risk spreading norovirus in relation to the control strategies. Several behavioural interventions were recommended based on the findings.

There was strong evidence for inadequate knowledge about norovirus and how to stop it spreading, so educational training for food handlers and FBOs was highly recommended. FSA is exploring the design and delivery of future interventions.

Environmental barriers were often identified both in terms of characteristics of the setting (time scarcity, business, workload, and in the case of returning to work, money and pay) and the physical design and infrastructure of food handling environments. Both frequent micro-behaviours (e.g. hand washing, glove use, surface cleaning) and less frequent behaviours (e.g. uniform cleaning and exclusion from work) were environmentally influenced.

### Action needed to improve Scottish diet

A report produced by Leigh Sparks, Professor of Retail Studies, and Steve Burt, Professor of Retail Marketing, at Stirling University and commissioned by Food Standards Scotland, has examined how the retail food sector can be altered the architecture of in-store choice. There is a need to consider a range of actions to confront consumers:

- Measures to be required by all food retailers
- Not regularly changing gloves
- Food handlers instead of trained staff cleaning areas where people vomited
- Not washing uniform correctly
- Returning to work too early after being ill

The report recommended:

- Training of staff
- Better understanding of consumer behaviour
- More effective enforcement of legislation
- Better communication with consumers

The report recommends action is needed to improve Scottish diet.

### Sushi success for Reading students at Ecotrophelia UK

The Yasai Sushi team from the University of Reading has been awarded the gold prize at Ecotrophelia 2017 for its veggie sushi-style rolls.

Yasai Sushi were packed with locally sourced vegetables, including crunchy cauliflower rice. The rolls are low fat, low-calorie and one portion provides two of your 'five a day'. Each member of the gold-winning team took home a share of £2,000 and an invitation to become an IFST Young Ambassador. Ecotrophelia gives students a taste of new product development. From an idea generation through to the final packaged product, the teams get hands-on experience of what it takes to bring an eco-friendly food or drink product to market.

Najren Juan, a member of the winning team, said: ‘We learnt a great deal during the competition, including things like costing, marketing and packaging. The key to our success was working as a team as we all had different backgrounds – food science, food technology, consumer science and nutrition.’

The awards were introduced by the competition’s Chief Judge and Head of Product Development Safety and Supplier Performance at Sainsbury’s, Alex Kyrkides, and presented by Peter Carter of M&S and at Campden BRI’s annual open day.

The Lagom team from Nottingham Trent University secured the silver prize and £1,000 with its vegetable spaghetti snack. The bronze prize and £500 was awarded to the London Metropolitan team for its vegan windfall fruit jelly, which is made from ‘fruity waste’. Judges from top names in the food and drink industry, including Marks & Spencer, Coca-Cola, Unilever, PepsiCo, Mondelēz, Sainsbury’s, Tesco, Warburtons and Food Manufacture, listened to the teams’ pitches and tasted the products before carefully considering each entry for its industrial feasibility, taste, eco-innovation, originality, creativity and innovation, and market credibility.

Andrew Gardner, Open Banking Director at IFST said: ‘We are delighted to see that Ecotrophelia UK is continuing to attract interest from the brightest teams around the country. The competition provides an excellent opportunity for students to showcase their talent and gain an insight into the whole food and drink industry, from product development through to marketing and finance. They are our future food scientists and technologists and this experience will be invaluable for their careers in the industry.’

The Yasai team will go on to compete against 19 other national teams from across Europe for the chance to win up to £6,000 at the European Ecotrophelia final, which will be held at Food Matters Live in London in November.

The UK heat of this Europe-wide competition was organised by the UK food and drink research organisation, Campden BRI, in conjunction with IFST, the independent qualifying body for food professionals in Europe.

www.ecotrophelia-uk.org #EcotropheliaUK

### Challenges in the Catering Industry – new food safety event

On 18 September 2017, IFST’s Food Safety Group will be hosting its latest interactive meeting for IFST members. These events provide expert perspectives on hot topics followed by a lively discussion, where members are able to share knowledge and experiences.

The focus of this event is Challenges in the Catering industry. Translating Science into Practical Solutions with a presentation from Dr Lisa Ackerley, Chartered Environmental Health Practitioner with over 30 years’ experience.

**LISA ACKERLEY**

Lisa is passionate about translating science into easily understood concepts and wants to provide practical solutions to the ‘real world’ food safety challenges – whether it is for the consumer or the food industry.

If it is easy to understand, then there is more chance of behavioural change.

Lisa will discuss the challenges, myths and legends relating to:

- Allergens
- Burgers and risky foods
- Food waste
- Disinfection residues and chlorine
- Antibiotic resistance

If you would like to register to attend this event, please visit https://www.ifst.org/events/challenges-catering-industry-

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**References and article available online at:**

www.ifstjournal.org/news

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**Vol 31 Issue 3**
New resource to support food science teachers across the UK

For our 50th Jubilee year in 2014, IFST launched a new free facility called FoodStart, which aimed to provide a single, online resource offering food related placements at all levels – from secondary school work experience through to undergraduate placements and internships. This was developed thanks to the generous support of a number of organisations and also personal donations made by many of our members.

The website launched in late 2014 but, despite considerable time and effort trying to encourage food employers to post placements, we struggled to get the anticipated numbers of placements to make the site a real draw for students. Therefore, with considerable regret, the Board decided earlier this year not to spend any more time on the promotion of FoodStart as a placement portal. The FoodStart name, we believe, does still have resonance and so we still want to put this to good use.

Given the food sector’s constant call to be more ‘joined up’ in the way it tries to attract young people to jobs in food, we have adapted the FoodStart site to be a single portal, sign-posting young people and teachers to some of the wealth of resources about careers in the food sector. The site now signposts not only IFST’s many initiatives but those from many other trusted sources.

We hope that through this new portal, young people will explore a wider range of organisations and resources about food careers. So, whilst the original FoodStart did not achieve the desired outcomes, the FoodStart aim of attracting young people to the food sector continues, thanks to many members’ generous support.

To access FoodStart, please visit www.foodstart.org.uk.

Food supply security is in the POST

The 2016-17 POST Fellow, Ruth Barnes, University of Reading, has published her POSTnote entitled ‘Security of UK Food Supply’. This marks the culmination of three months of research while working at the Parliamentary Office of Science and Technology (POST).

Each year the POST receives funding of £5,000 for a PhD student to spend three months working at Parliament. This POSTnote. These are published to provide parliamentarians with a digest on topical subjects within science and technology.

The security of UK food supply is a key priority for the Government, particularly in light of the UK’s withdrawal from the EU. This note outlines current UK trade in food and animal feed, examines the challenges for security of the smaller ones with new, unique solutions, including sugar replacements and alternative proteins.

We were introduced to products we had never even considered (or heard of!), for example watermelon seed protein and monkfruit syrup, which opened our eyes to the new ways the food industry is expanding to meet consumer needs. It put into perspective all that we had learnt in our first two years at university and has equipped us well for the first few weeks of our placement year.

As well as improving our knowledge, IFT17 was a lot of fun and very sociable – a fantastic opportunity to meet FoodScience students (and compare the differences in our courses) as there were so many occasions to network.

We had the privilege to watch the premiere of the IFT film, ‘Food Evolution’, a scientific documentary highlighting the facts and importance of genetically modified foods around the globe. We both thoroughly enjoyed the way the film portrayed the truth and science behind genetic modification and are hoping to arrange a screening at Reading University. College Bowl, a food science based student quick-fire quiz show, was another IFT17 highlight – very exciting and incredible knowledge by those taking part!

We’d both recommend attending future IFT conferences to any student or industry professional. A big thank you to IFST and IFT for making this opportunity possible for us both. Not only did we learn so much at IFT17, we also got to explore Vegas and even see the Grand Canyon by extending our conference stay for a short time.

I strongly encourage other students to take advantage of this wonderful opportunity that I feel will help me both with my current studies and with other future projects.

Read the full POSTnote at: http://researchbriefings.parliament.uk/ResearchBriefing/Summary-POST-PN-0556
International Journal of Food Science + Technology

IJFST is making an even bigger Impact

We are delighted that the 2017 Impact Factor for the International Journal of Food Science & Technology (IJFST) has risen to 1.64. This represents the fourth consecutive year of impact in the journal and illustrates a continued strong performance of IJFST. IJFST’s purpose is to promote new knowledge and techniques in the food sciences and particularly to serve the industrial and research communities by providing high quality refereed original papers in food science and technology. Both technical and research papers are considered for publication. For IJFST members, IJFST is available free of change and in print form at discounted rates.

Recent IJFST highlights relating to agri-tech

- Steviol glycosides unaltered by extraction and purification
- Steviol glycosides, sweet diterpenes extracted from the shrub Stevia rebaudiana Bertoni, are approved as sweeteners in many countries throughout the world. Earlier heat and pH-investigations of these glycosides established their stability. However, due to the complex purification process, the natural steviol glycosides have recently been challenged.

The objective of this work was to see whether the steviol glycosides are chemically modified during the commercial extraction and purification process. Samples of three independent commercial-scale extraction and purification batches of steviol glycosides, each batch being a sample of the untreated stevia leaves, the first water extract and the high-purity product, were analysed using HPLC-UV and HPLC-ESI-MS/MS.

The results show that the commercial powders of extracted steviol glycosides with an estimated purity of more than or equal to 95% contain the same steviol glycosides as the dried stevia leaves and their hot water infusions, demonstrating that steviol glycosides are not altered significantly during the purification process.

(Oehme et al., 2017, doi: 10.1111/ifo.13494)

- Wine authentication
- Wine aging in wooden barrels improves the final product’s sensory profile and increases the price. Among the different types of woods, the International Organisation of Vine and Wine (OIV) recommends oak, which is an essential ingredient of the International Organisation of Vine and Wine (OIV) approved only the use of Oak and Chestnut, thus producing a need for fast and cost-effective authentication methods. In this study, Fourier Transform (FT)-mid-infrared (IR) spectroscopy combined with chemometrics was employed to analyse and discriminate wines aged in barrels made from different wood species and in stainless steel tanks over a period of 12 months. The wines were made from four indigenous Greek grape varieties, two white and two red. A complete differentiation of the samples was achieved according to grape variety, the container type and the aging time based on two spectral regions from (1800 to 1500) cm⁻¹ and from 1300 to 900 cm⁻¹ of their FT-IR spectra.

(Basileou et al., 2017, doi: 10.1111/ifo.13424)

- Nutrient location in cereals
- The histological localisation of phenols and β-glucan were compared in six cereal cross sections. The concentrations of β-glucan and total phenols in whole grain flour (WGF) were also investigated. Cross sections of durum, soft, einkorn and emmer wheat, oats and barley were stained with Azan Trichrome (ATH) and periodic acid-Schiff (PAS) to characterise the morphology and cytohistology of the living cells in the aleurone, subaleurone and germ, as well as the starch endosperm.

In this study, cereals and cereal products were evaluated with an estimated purity of at least 95% for Athanerum and periodic acid–Schiff stained with Azan Trichrome (ATH) and periodic acid–Schiff (PAS) to characterise the morphology and cytohistology of the living cells in the aleurone, subaleurone and germ, as well as the starch endosperm.

(Panaso et al., 2017, doi: 10.1111/ijfs.13390)

Life after leaving the EU: have your say

If you are interested in understanding how the future may look after Brexit in the area of food regulation and want to have your say on key topics in this field, you cannot miss the next event organised by IFSF’s Eastern Branch on 19 October 2017. This session will bring together five knowledgeable speakers on novel foods, nutritional/health claims, biocides legislation, food hygiene and food information standards/labelling regulations in a forum that will enable cross-examination of the issues raised and provide the opportunity to vote for your preferred outcome. To find out more about the speakers and to book your place, please visit the website:

https://www.ifsft.org/events/food-regulations-post-brexit-%2E2%28%299-have-your-say
Help for grads and early career development

We recognise that it can often be a daunting time for those of you who have just graduated and are about to enter the food industry. This is why we have created the New Professionals Steering Group, which aims to support recent graduates and early career members of IFST through regional events, forums, discussions and much more! If you have any suggestions for the group as to what they can work on, please contact Erin Taylor at e.taylor@ifst.org.
Breeding crops for the future

It is widely accepted that by 2050 we will need to feed 9 billion hungry mouths and food production will have to increase. It will not be possible to bring much more land into production and resources are already stretched.

This is the challenge farmers are facing whilst dealing with ever more volatility created by climate change, price fluctuations, regulatory change, socioeconomics, demographic and geopolitical shifts. Pests, weeds and diseases continue to threaten both quality and quantity of food production. Access to new and innovative plant varieties will be a vital tool in managing these challenges. This article examines the potential benefits that New Breeding Techniques, or improved plant breeding, can bring to the field.

What are New Breeding Techniques?

Throughout history, as knowledge of plant biology and genome diversity advanced so did breeding tools, continuously resulting in new opportunities to enable rapid identification and breeding of desirable characteristics in plants.

New Breeding Techniques are relatively easy, quick and cheap to use by comparison with traditional methods. They therefore allow breeders to focus more on ‘niche’ crops or localised growing conditions and to react more quickly to the challenges outlined above. But biotechnology is not the silver bullet; it is part of the farmer’s toolbox along with increased knowledge and understanding of agronomic practices as well as business management. This holistic principle is one practised by farmers across the UK and EU. If one tool is restricted, by default the rest are limited. Currently genetic improvement is a longer-term option as commercialisation of a new variety can take over ten years, so the possibility of speeding this process up is very promising.

It is not just farmers who stand to gain. There are also benefits for consumers. These techniques can be used to manipulate genes in very specific ways. This could result in enhanced nutrient content, increased shelf life through the reduction of oxidation and bruising and improved colour, aroma, flavour and texture. These benefits are already being explored and realised by our competitors around the world. For example, in the US, a browning-resistant mushroom and a potato with better storage properties have been produced using gene editing.

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Source: Houses of Parliament, Parliamentary Office of Science & Technology, Postnote, Number 548, February 2017

Benefits of New Breeding Techniques

Through traditional plant breeding, yields are roughly increased by 1-2% a year for some crops, so that between 1990 and 2000, global food production increased by 25%.[1] However, according to the Agricultural Outlook 2012–2022[2] by the Organisation for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO), actual yields for the main food crops are well below potential yields in a number of regions, with yield gaps in many developing countries in excess of 50%. New Breeding Techniques offer considerable potential to address this shortfall.

Some of the New Breeding Techniques are relatively easy, quick and cheap to use by comparison with traditional methods. They therefore allow breeders to focus more on ‘niche’ crops or localised growing conditions and to react more quickly to the changing needs and wants of growers and consumers. For example, this could include improvements, such as crops that are better suited to more extreme conditions. Drought resistance of crops is a key challenge globally and would be increasingly valuable in the UK, as demonstrated by the dry conditions experienced this season. Some scientists even have the very ambitious goal of knocking out gluten production in certain cereal crops.[3]

This type of innovative plant breeding is welcomed by farmers and could result in genetic solutions to their problems sooner, helping them to adapt more quickly to the challenges outlined above. But biotechnology is not the silver bullet; it is part of the farmer’s toolbox along with increased knowledge and understanding of agronomic practices as well as business management. This holistic principle is one practised by farmers across the UK and EU. If one tool is restricted, by default the rest are limited. Currently genetic improvement is a longer-term option as commercialisation of a new variety can take over ten years, so the possibility of speeding this process up is very promising.

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These benefits are already being explored and realised by our competitors around the world. For example, in the US, a browning-resistant mushroom and a potato with better storage properties have been produced using gene editing. Disease resistance is a huge focus for the plant breeding community and already powdery mildew-resistant wheat and blight-resistant rice have been bred in China and the US respectively. Today’s health-conscious consumer will also be interested in a high oleic acid oil from scientists in Minnesota[4]. Its oil is higher in mono-unsaturated fatty acids and lower in polyunsaturated fatty acids and therefore better for human nutrition.

Regulation

Whilst there is huge opportunity for these new techniques to benefit the agricultural industry, realising this potential largely depends on how they are regulated and progress has been extremely slow at the EU level. There is uncertainty about the extent to which some of these techniques involve GM and therefore whether they should be regulated as such. The long history of controversy and emotion around GM means decision-making may not be based on robust scientific evidence.

The European Union considers an organism to be genetically modified if it has been altered in a way that does not occur naturally by mating and/or natural recombination. Many of the new techniques rely on the mechanisms that can be triggered through traditional breeding techniques. Although the mutations generated may not have occurred naturally, the end product is
NEW BREEDING TECHNIQUES

indistinguishable from those arising naturally or through conventional mutation breeding. The European Food Safety Authority (EFSA) and the Joint Research Centre (JRC) concluded that the legal definition of GMO does not apply to plants produced by most of the New Breeding Techniques, so they should be exempted. They argue that the resulting plants are not different from those obtained by means of conventional breeding or they lead to plants that contain no foreign DNA.

The view that most of these techniques do not produce GMOs is shared by ACRE, the UK Government’s Advisory Committee on Releases to the Environment. There is also a general scientific consensus that most of these techniques are not GM. However, the process of regulation has become political with many non-governmental organisations (NGOs) and MEPs claiming that all of these plant breeding innovations should fall into the GMO definition.

This uncertainty has been brewing in Brussels for several years, leaving the European research community and industry without clear legal guidance. Meanwhile other countries around the world have already begun to realise the benefits varieties bred using these techniques can bring, once again placing the UK behind its competitors.

An extreme interpretation of the precautionary principle should not be allowed to stifle technological progress. These plant breeding innovations have the potential to help solve production challenges faced by British farmers, allowing them to build resilience and compete in the global market.

The NFU’s position

The NFU always promotes the use of robust scientific evidence in the regulation of any agricultural technology. The innovation principle should be invoked in this case, leading enabling and fit-for-purpose regulation.

Europe is being left behind as the rest of the world rapidly adopts new and innovative breeding technologies. This is already damaging the UK’s competitiveness, driving seed companies away from Europe and deterring research and investment in varieties that could benefit British farmers, the environment and society.

The NFU would therefore like to see New Breeding Technologies regulated in accordance with the scientific consensus that most of these techniques do not produce GMOs.

References and article available online at: www.fstjournal.org/features/31-3/new-breeding-techniques

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Waste not want not

Pascale Martin, founder of Agronomex, describes the company’s ambition to facilitate the direct trade of surplus fresh produce in the UK via a B2B web platform and to improve the efficiency of the supply chain.

Resource optimisation

The UK fruit and vegetable supply chain is facing significant issues with edible surplus wastage. With 85% of agricultural production going to retail, the main UK retailers have a large impact on UK farming production practices. Many UK farmers are contracted to big retailers; contracts often impose an obligation on farmers to make produce available at a specified time and with predefined marketing standards.

In addition, consumers continue to demand high quality produce and retailers respond to this by rejecting up to 40% of total agricultural yields. In the absence of alternative market opportunities, surplus and sub-standard produce is simply left in the field to rot incurring huge losses to growers. The Global Food Security Program estimates that 20 to 40% of edible produce is wasted at the farm gate (harvested or not harvested). There are several reasons why growers are left with excess crop, including stringent marketing standards, changes to fencasts or fluctuations in demand.

According to ‘The Horticulture Innovation Partnership’, imports represent 34% of the source of supply for food processing companies in the UK[1] (Figure 1). Because of this strong dependence on imports from the EU, particularly in a Brexit context, horticulture products grown in the UK bring valorisation and optimisation of existing local resources.

The UK agrifood industry is seeking innovative solutions and new technologies to improve its competitiveness and to boost the productivity of UK food businesses, use resources more efficiently and become more sustainable throughout the food supply chain[2].

Web platform

The London based start-up, Agronomex, is offering a new, sustainable solution to tackle the problem of fresh produce wastage at source. The aim is to turn surplus fruit and vegetables into income and reduce the sourcing costs of buyers.

A finalist of the AgriTech East GROW competition in June 2017, Agronomex is building a B2B web platform to facilitate direct trade of surplus produce through technology and resource optimisation. This is made possible by offering a single interface, linking fruit and vegetables suppliers with food processing companies and providing the appropriate support to manage supply and sourcing processes from one single location. The intention is to improve market transparency and communication within the supply chain.

Volumes of edible crop wastage are so large that a B2B approach offers the most appropriate and sustainable solution. The Agronomex platform is built on an auction model, where suppliers can promote and sell their available produce while buyers can post their sourcing needs. In response to these posts, suppliers can make an offer of available produce to potential buyers.

From the buyer’s perspective, reducing sourcing costs is a priority, but they also require guaranteed quality in line with food safety and traceability requirements. Suppliers are encouraged to provide evidence of product quality that buyers can consult on-line. In this way, suppliers maximise their chance of finding a buyer and buyers can select only suppliers meeting their required standards. A single ID is allocated to each successful trade.

A ‘forward contract’ option is also available. This gives primary producers the opportunity to sell produce before harvesting and thus reduce their risk of unsold produce leading to wastage and losses. On the other hand, purchasers can secure their produce needs in advance.

Easy to use

In only a few clicks, users can sell or buy fresh produce as well as managing associated actions. Users log into the Agronomex website and complete a user profile with information related to their type of business, type of produce supplied and collection/delivery address. Suppliers are encouraged to upload online any documentation that could maximise their chance to find a buyer, from quality certifications, crop records to images of the produce for sale.

One reason given for not harvesting surplus crop is the lack of guarantee of selling at an economically viable price. Suppliers set up the auction, determining the asking price and the bidding time as well as the quantity to be sold in one batch and the grade.

Shelf life might vary significantly depending on the produce and the supplier is in the best position to determine for how long the produce is viable. Suppliers can also market produce for animal feed or anaerobic digestion (AD). Although some produce might not be fit for human consumption, it still has a value and can be redirected to animal feed or AD for valorisation rather than sent to landfill.

Because supply chains are often complicated, the procurement process is time consuming and resource consuming, creating a challenge for each agri-food business. Agronomex offers procurement teams an efficient and sustainable eSourcing solution helping them to be more cost efficient, without reducing quality and food safety.

Since payment can be a barrier for suppliers to trade with new buyers, the platform offers payment facilities and a credit check for each buyer. Suppliers are guaranteed payment within 3-5 working days once the trade is finalised and buyers have access to on-demand extended payment terms where applicable, accessible from the platform.

Logistics

Agronomex is also establishing a logistics solution on-demand by teaming up with a freight exchange platform to minimise dead mileage and part loaded trucks. Such a system could significantly reduce logistics costs.

Pilot phase

Agronomex is working on the development of its network and looking for new users who want to join its pilot phase, starting soon. It is looking for food manufacturers which buy fruit and vegetables as ingredients for other products, including large restaurant chains, and processing firms specialised in fresh produce.

The pilot will commence with suppliers from farms in the east of the UK, allowing access to the largest volumes and a wide range of produce, before being expanded nationwide. The initial focus will be on farms under contract with big UK retailers, which are the most likely to have secondary produce.

Alongside this, Agronomex is raising funds to move the business to the next level. It is keen to meet people from the industry who wants to learn more about this venture or want to share feedback and experience. Its objective is to be the first fruit and vegetable spot market for B2B users in the UK.


References and article available online at: wwww.fstjournal.org/features/31-3/trading-food-surpluses

Pascale Martin, founder, Agronomex

Pascale left her permanent job in an investment bank to work full time on this new venture with the objective of building a global solution for a more efficient and fruit and vegetable supply chain. For more information contact Agronomex: Email: pascale.martin@agronomex.com

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Spotlight: Agri-EPI Centre

Vickie Cooper and Rob Merrall explain the objectives of the new Agricultural Engineering Precision Innovation (Agri-EPI) Centre.

The Government has invested £68 million in three new Centres for Agricultural Innovation. Announced in the Autumn Statement in November 2016, the three new centres will stimulate inward investment and help to revolutionise farming practices in the future as well as creating capacity in the UK to translate agricultural innovation into commercial opportunities for UK businesses.

The investment will finance world-class laboratory equipment, IT hardware and software, and facilities to test and develop new agricultural technology and products. The three new centres are CIEL (Centre for Innovation and Excellence in Livestock), Agrimetrics, CHAP (Crop Health And Protection) and the Agricultural Engineering Precision Innovation Centre (Agri-EPI Centre).

The Agri-EPI Centre comprises three hubs with HQs in Edinburgh, at Penicuik (close to SRUC’s Roslin Institute), at Cranfield University in Scotland, and at Harper Adams University in Shropshire. These three academic founding organisations deliver technical and expertise brought in as needed, but the concept of the hubs is that they should act as small business incubation centres for embryonic spin-outs. Providing serviced office and supported technical development facilities for micro businesses and SMEs is the first of a three-strand business model, which provides sector-specific ‘nurturing’ for micro businesses within a creative, innovative culture.

Second is the hosting of targeted research by small focused teams from a range of large and medium sized agri-tech based companies. Dedicated and discrete workshop space is available for hire with specialist technical expertise on hand as required. Businesses benefit from having their teams embedded in an innovative research environment, whilst having access to cutting edge facilities and agri-tech specialists, resources that they may not have within their existing businesses.

The third and most potentially game-changing strand involves supply chain issues being brought to the Agri-EPI Centre by member companies. Production problems are highlighted by the supply chain, usually from the retail and via a UK supermarket (most of whom are now signed up members). This might be a production consistency issue and EPI then identifies a suitable R&D funding stream (very likely a collaborative Innovate UK opportunity), and puts together an appropriate bid to address the supply chain issue identified. A typical example of this kind of R&D project might involve novel sensor or robotics technologies being developed to fit into a typical production system, with a potential project consortium involving a plant breeder, sensor or robotics specialist, existing agricultural machinery manufacturers, growers and their wholesale or supermarket customers. The satellite farms can contribute by becoming a bench testing facility for the novel technologies developed.

Satellite farms

Thirty-two commercial farms have signed up to form the Agri-EPI Centre satellite farm network. They have been carefully selected so as to provide a wide geographical spread within the UK and give a representative cross-section of UK agriculture. Poultry, pigs, dairy, sheep, beef, cereals, vegetables, horticulture and fish farming are all represented.

A significant portion of the capital spend for the Agri-EPI Centre is being employed to facilitate connectivity at the satellite farms, which is well underway. Investments in weather stations, conference facilities, connected Skype cabins to facilitate meetings and overall connectivity to make it possible to test novel sensors requiring WiFI or cutting edge wide area network solutions have been put in place. Each farm will have space for researchers to work with the luxury of a reliable high-speed broadband connection. The farms will have farm-wide, low powered WiFi allowing the transmission of data from wireless sensors around the farm seamlessly back to the base station and subsequently to the Centre’s cloud based data platform.

The farms are providing a plethora of historical production data, such as soil maps or milking performance data. This enables the effects of dry seasons and wet seasons to be compared so that the likely impact of novel systems can be extrapolated with a reasonable level of confidence using real production data collected over a relatively short period (one or two seasons).

In addition to this, part of the budget is dedicated to increasing the amount of data collected at each farm. This could be the introduction of health tracking collars on a dairy herd, cameras that monitor the growth of pigs, or a drone to collect crop health maps – anything that can measure variance within the agricultural processes can provide valuable data. This real-world data is analysed and stored in the Centre’s cloud platform. It will be hugely valuable for customers looking for benchmark data to assist with development of products.
Another way in which Agri-E PI’s Satellite Farm Network can be of benefit to its customers is by providing huge potential for large scale field trials, creating opportunities to benchmark and gauge the commercial impact of new technologies as applied to real world production systems.

Whether companies are trialling new technology or doing project work, the Centre has the facilities to conduct studies on real commercial enterprises, right across the UK. The good connectivity takes a lot of the difficulty out of conducting project work in remote locations and the amount of benchmark data available on these farms also makes verification of results much more straightforward and valid.

The network can also be used for holding meetings to showcase products or ideas, or even linking in to conferences throughout the UK via Skype. Perhaps the most important role that the network plays, is the real connection it gives to industry. Not only does this provide a stream of ideas and problems that farmers have encountered in the field, it also represents an invaluable source of industry knowledge and experience that can feed into other activities.

The list of putative projects continues to grow and it will be very interesting to review the impact of the connected satellite farms on the Centre’s performance in a few years. The satellite farms themselves will continue to be independent, production-orientated businesses throughout. The EPI-Centre team believes this production focus is important and will enhance the commercial impact of the Centre’s work.

Technology areas

The Agri-EPI Centre’s focus on precision agriculture is based on a vision of reducing production variability. Precision farming of crops involves dividing farmed land into management zones, which have specific characteristics – soil being one of the most important. Using such precision data has been proven to lead to better yield results across all crops when compared with traditional and conventional farming. However, to date, the perceived high cost of entry has proved a barrier for many small-scale farmers.

Precision farming of livestock is all about understanding the individual animal’s production characteristics in a systematic way and specifically optimising production parameters in such a way as to focus production on meeting a desired specification whilst minimising variance.

Sensors, machine vision and robotics

The Agri-EPI Centre aims to bring technology from the automotive and aerospace sectors to bear on some of these agricultural production optimisation problems. It is anticipated that novel sensor technologies from these sectors will make possible new approaches centred on low cost, network enabled sensors. Machine vision techniques will open up possibilities not before considered feasible in the areas of classification, identification, quantification and task-orientated position sensing.

This last point is particularly important for improved interaction of robotics with biological production systems. Significant moves forward in all of these areas can be expected over the next few years, which will impact on agricultural production efficiency and sustainability.

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References and article available online at:

www.fstjournal.org/features/31-3/agri-epi-centre

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As a major consumer of natural resources, the food industry is under increasing pressure to reduce its carbon emissions and its wider impact on the environment. Food and beverage businesses also need to access alternative clean sources of energy not only for their production processes but also for the transport of raw materials and products. Generating bio-energy on-site, including biogas from factory process residues, can offer an attractive solution to both these requirements.

Developing bio-energy solutions, such as bio-methane for commercial transport fuels, offers an opportunity to employ innovative engineering skills to make better use of available resources. The circular economy requires new sources of raw materials, more efficient production and packaging systems and low-carbon fuels for production and delivering products within the retail system. The food industry is already replacing more traditional, energy-intensive solutions for disposal of its processing residues with on-site bio-energy generation. Developing clean transport fuels can further transform outdated business models that evolved when resource efficiency was of less concern. Production of bio-fuels from residues is already happening and bio-methane is available from existing supply chains, including an increasing number of anaerobic digestion (AD) plants on factory sites.

Richard Gueterbock of Clearfleau and Andrew Winship of Aker Associates explain the benefits of using biomethane generated on-site from food and drink process residues as a fuel for HGVs.

Decentralised on-site bioenergy

Food and drink manufacturers are recognising the commercial benefits of decentralised energy from bio-feedstocks. This includes deploying AD to convert energy-rich process residues, such as those from distilleries and dairies, into valuable renewable energy for use in the factory, while minimising disposal costs and cutting fossil fuel consumption by up to 30%.

In the past decade, about 30 such AD plants have been built on UK factory sites, reducing emissions and providing an attractive return on investment. For example, one of Europe’s largest cheese creameries, First Milk’s Aspatria in Cumbria, uses this technology to provide energy to power the factory. The on-site AD plant converts unwanted cheese-making residues into biogas, supplying upgraded biomethane via the gas grid to the site and other local users. The process allows First Milk to save money on its fuel bills, avoid previous costs of disposing of the residues and reduce the site’s carbon emissions.

AD is converting co-products from Diageo whisky distilleries in the Scottish Highlands to biogas to heat the stills and is also being used in the dairy, food and biofuel sectors. Decentralised energy potential in these sectors is based on the latent calorific value of energy-rich liquid (and solid) process residues. Ongoing technology improvements (e.g. process control, biogas yield, COD removal efficiency, ability to recycle grey water or plant footprints) have enhanced potential payback. The challenge faced by industry and its regulators is to extend this approach across the food processing sector.

Enabling smaller factory sites to make use of the calorific value in their residues, rather than export their potential energy value, represents progress towards a more circular economy.

Bio-energy alternatives to fossil-fuel based energy are not limited to biomass and bio-digestion but include fuel cells and hydrogen energy. Benefits include improved bio-security, as residues are converted to energy where they arise without having to be stored or transported. Substituting fossil fuels with biogas, biomethane, biodiesel or hydrogen adds value to discarded materials, reducing production costs. The benefits of on-site bio-energy are clear but, particularly with smaller sites, the technology must meet energy needs, be affordable and match the space available.

With on-site digestion, individual facilities are tailored to the specific requirements of the site. Developing a more modular approach to plant design helps to facilitate export opportunities and make plants affordable on smaller industrial sites. As the government continues to curb the incentives that have stimulated investment in renewable heat and power, bio-based fuels are becoming an increasingly attractive alternative to high-emission fuels, such as diesel, in the transport of heavy goods vehicles (HGVs).

Richard Gueterbock of Clearfleau and Andrew Winship of Aker Associates explain the benefits of using biomethane generated on-site from food and drink process residues as a fuel for HGVs.
or liquefied to produce the fuel. The Clearfleau study included a detailed financial evaluation of both CBM and LBM conversion, showing an attractive return on investment, which will improve as diesel prices rise.

Simple payback at a smaller milk creamery for CBM was estimated at 5.7 years and for LBM at 7.5 years, comparing favourably to using biogas in combined heat and power (CHP) units to generate electricity at 5.6 years. The economic viability of biomethane for industrial transport also depends on a range of site-specific factors, such as the number and type of trucks and how they operate from the site, the quantity and nature of organic residues available, volume of biogas produced and site location.

Currently, the dominant fuel for commercial vehicles is diesel. Concern about air pollution contributing to premature deaths of thousands of people each year has resulted in the emergence of clean air zones in cities to restrict the movement of the most polluting vehicles. It may even result in a ban on the use of diesel in major cities, as reported recently in Paris. This will have a major impact on the operations and profitability of food and drink manufacturers, which will need to find alternatives to diesel. While there has been huge growth recently in the uptake of electric vehicles, this is not a viable solution for commercial transport, as the technology is not suitable for larger, heavier trucks.

Converting process residues from food and drink manufacture into biomethane is therefore an obvious solution. Vehicles are continuously entering and leaving the site making it an ideal location to set up the refuelling infrastructure, with the feedstock (residues) to produce the fuel readily available. By producing renewable fuel on-site, a business can help insulate itself from rising prices and make fuel cost budgeting more predictable.

Elsewhere in Europe, use of biomethane as a transport fuel is not new. Other European countries have developed a market for gas-powered vehicles, with production and refuelling technology having been in use for many years for commercial transport fleets using gas to power HGVs. Companies like Arla and Waitrose are using compressed or liquefied natural gas (CNG and LNG) and biogas alternatives, with trials showing the potential to deliver significant greenhouse gas savings. Gas-powered HGVs have been demonstrated to produce lower emissions of NOx, particulates and CO2 and are claimed to be quieter. Biomethane provides an even lower carbon alternative to the CNG and LNG powered trucks already being used in some commercial vehicle fleets.

In the UK, incentives are in place to encourage wider adoption of biomethane as a transport fuel through the Renewable Transport Fuel Obligation (RTFO) and by development programmes like the recently announced Future Fuels for Flight and Freight Competition. Converting process residues into renewable transport fuels is economically viable, giving the food and drink industry another option in its progress towards emissions reduction, improved sustainability and embracing the circular economy. Government could do more to encourage the wider use of gas engine technology.

Promoting a low carbon economy After the 2015 Paris COP21 Climate Change Convention, a group of leading food and drink sector multi-nationals made commitments to change their practices, signing a statement of intent. We want the facilities where we make our products to be produced by renewable energy, with nothing going to waste, as corporate leaders, we have been working hard toward these ends, but we can and must do more.

With global food companies setting ambitious targets for reducing greenhouse gas emissions and developing a more circular economy, British firms need a supportive policy framework. Companies that have installed on-site bioenergy plants are benefiting from incentive revenue and cost savings, while boosting their CSR profile – compelling reasons for the Government to promote the demonstration and adoption of biomethane as part of its industrial strategy.

The bio-economy (including biomass for transport) could contribute about £36 billion in gross value added (GVA) to the UK economy, of which over 80% is from food and farming. In 2012, industrial biotechnology and bio-energy contributed 3% to the sector’s GVA, with the right support this can grow substantially. The technology for producing low carbon bio-fuels from process residues is already well established and biomethane offers an existing supply chain with an increasing number of AD plants on factory sites.

In developing its ‘Clean Growth Strategy’ the Government needs to provide a period of policy stability for industrial bio-energy to fulfil its potential. Smaller businesses need support if they are to match investment in the circular economy by larger companies. With British bio-energy companies developing smaller on-site solutions, wider adoption of industrial bio-energy can stimulate economic growth, boost engineering jobs, help the UK meet sustainability goals and encourage innovation.

References and article available online at: www.fstjournal.org/features/31-3/biogas-fuel

Richard Gueterbock, Marketing Director for Clearfleau, has been with the company since it was founded. He has a background in the agri-food sector and is a former trustee of the Royal Agricultural Society of England. Clearfleau is a provider of on-site bioenergy plants for food and beverage processing factories, with operational plants and others in build in the food, dairy, drinks and biofuel sectors.

Andrew Winship, Director Aker Associates, has more than 25 years of experience gained from working in the oil, chemicals and clean energy sectors. His areas of expertise cover combustion processes, biogas/biomethane, hydrogen and CO2. Aker Associates is an independent consultancy and advisory business to the clean energy sector specialising in business development, technology commercialisation, innovation management and project development.

To find out more about using Biomethane as Transport Fuel or to download a summary of Clearfleau’s report, please visit http://clearfleau.com/summary-of-report-on-biogas-for-commercial-vehicle-fuel-july-2017/
Giant LEAP for micro-scale AD

Could nutrition-packed, freshly-picked local produce, grown using energy and fertiliser made from food waste become the norm in cities of the future? Helen Theaker, Mark Walker and Rokiah Yaman have been exploring a circular organic model that could yield social, environmental and economic benefits.

Background
Every year, an estimated 10 million tonnes of food waste in the UK is thrown away – including 5 million tonnes from households. In the move towards a low-carbon society, managing this problem needs to be a priority. The best solution is to avoid creating waste, but some cannot be avoided and other solutions need to be explored. Food waste collection by local councils is continually rising and is now provided to 100% of households in Wales and Northern Ireland, 91% in Scotland and 52% in England. This means that diverting food waste away from landfill is becoming more feasible, opening the door to other treatment options, which can help to realise the inherent value contained in organic waste. An alternative to landfill and the more energy-efficient option of ‘energy from waste’ (normally incineration) is anaerobic digestion (AD). This is a renewable energy system that can be used to break down ‘wet’ organic matter in a controlled way, which allows the products to be captured. Energy is released in the form of biogas, made up of methane and carbon dioxide, which can be collected and used for cooking, electricity generation, heating, transport, or can be upgraded and injected into the national gas grid. A nutrient and fibre-rich fertiliser, known as digestate, is also produced, which can be returned to farmland to boost the health of the soil and replace artificially-produced fertilisers.

It has been widely reported that the concentration of nutrients in our fruit and vegetables has declined since the 1950s,[1] most likely due to a combination of early harvesting, longer transportation journeys, crop selection for disease resistance and reduced nutrients in the soil. An innovative system of circular organic resource management could help to address these issues. AD can form an important part of this system, where instead of losing nutrients and energy when food is thrown away, it is put back into the soil, allowing it to re-ingest. At the same time, emissions from waste in landfill are avoided and renewable energy and heat are created.

There is currently 430 MW of AD installed in the UK, providing about 1.4% of the UK’s electricity demand, with 40% of this coming from food waste. However, if all of the food waste produced in the UK was processed by AD, it could supply up to 4% of our electricity demand and satisfy 5% of our fertiliser requirements. In general, AD facilities are, by economic necessity, large-scale plants located in the countryside away from built-up areas. Extended storage times, crop selection and extended agricultural land means that diverting food waste from landfill is becoming more feasible, opening the door to other treatment options, which can help to realise the inherent value contained in organic waste. An alternative to landfill and the more energy-efficient option of ‘energy from waste’ (normally incineration) is anaerobic digestion (AD). This is a renewable energy system that can be used to break down ‘wet’ organic matter in a controlled way, which allows the products to be captured. Energy is released in the form of biogas, made up of methane and carbon dioxide, which can be collected and used for cooking, electricity generation, heating, transport, or can be upgraded and injected into the national gas grid. A nutrient and fibre-rich fertiliser, known as digestate, is also produced, which can be returned to farmland to boost the health of the soil and replace artificially-produced fertilisers.

The LEAP project
Established in 2012, LEAP (Local Energy ADventure Partnership) has developed a decentralised, urban closed-loop model, where food waste is processed on-site using micro-scale AD. Biogas is used to supply local energy needs, while the digestate replaces artificial fertiliser supporting local, intensive urban agriculture. The micro-AD systems used by LEAP are around 1/1000th the size of their industrial counterparts but are still able to convert food waste into valuable products by the same process. LEAP’s vision is clear: prioritise local organic resource management to create a recipe for low carbon, resilient, economically viable food production.

In moving towards the organic circular economy, LEAP seeks to embrace not only environmental and economic aims, but also social aspirations, including public engagement, educational, training and employment benefits (Figure 1). Its initial focus on the viability of micro-AD in the urban context addressed issues of odour, cost, user friendliness and lack of food growing space.

During 2012-13, LEAP compiled two feasibility reports. The first focused on the potential for a micro-AD network in the London Borough of Camden. It highlighted how resources, such as technical expertise and smart data analysis, could be shared. The second looked at the potential for AD on a nearby railway embankment site and the produce supplies the café.

The second plant is situated at the Calthorpe Project, a community centre and garden with an established food-growing area. Here, another closed-loop café has been set up, feeding the digestor with food preparation waste, while biogas is used on-site for cooking and generating heat. In colder months, the growing season will be extended in the polytunnel, where hydroponic experiments are underway to see whether soilless or soil-based growing is the way forward for using digestate in limited urban spaces (Figure 4). The third plant in East London is part of R-Urban, an EU funded project developed in conjunction with public works, an architect and artist collective that specialises in participatory design. The AD system was assembled in a shipping container by participants over a series of knowledge-sharing workshops. This system, sited on a social housing estate as part of a community reuse resource that will include a tool library, workshop space, café and community energy hub, will soon be commissioned (Figure 5).

Case study
The 2m³ AD plant at Camley Street Natural Park, near Kings Cross (Figure 2), sits overlooking a canal in a beautiful nature reserve. Zero carbon collections within a 1-mile radius use a cargo bike to transport catering and office food waste to the digester (Figure 3). Biogas is used for cooking on-site by Wildwood Community Café – set up as an intrinsic part of the closed-loop model, while café food waste is fed to the digestor. Digestate is used as a fertiliser for food growing on a nearby railway embankment site and the produce supplies the café.

The micro-AD systems used by LEAP are around 1/1000th the size of their industrial counterparts but are still able to convert food waste into valuable products by the same process.”
The plant was profiled in terms of its stability, ability to digest waste and its energy usage in comparison to larger AD facilities. The study was the first detailed assessment of a community-based micro-AD in the UK and was recently published by the University of Sheffield in Waste Management Journal [2]. At its target feeding rate, the AD system was fed on an average of 25kg a day of food waste, mostly from local businesses. As the project progressed, maintenance and improvements were made to the plant to keep it running smoothly. This included the automation of the feed system, which gave the plant a predictable and regular feeding pattern, and the development of a bespoke boiler and hob to burn the gas.

Many measurements were taken from the AD plant during the study, which allowed researchers to confirm its stable and successful operation. In fact the micro-scale plant was very different because, unlike a standard large digester, which gives the plant a predictable and regular feeding pattern, and the development of a bespoke boiler and hob to burn the gas.

AD is already a more complex process than composting, so simplifying user operation through good design is essential. Having straightforward procedures, monitoring and maintenance routines makes it easier to maintain a healthy and efficient biological process. Odour is another key issue, which good design can help eliminate. Housing digesters within a structure not only helps minimise heat losses but also keeps odour during operation inside the building. Hygiene protocols also reduce smells and maintaining steady operation of the system makes a difference, as irregular feeding causes instability, which can increase odour generation.

Good engineering design and training are both critical to the success of a plant. While the technology is relatively simple, it benefits hugely from AD design experience and the operator understanding the process, since mistakes can easily be made without knowledge of the subtle interactions between feedstock, process, design and operation. LEAP has found that its operators can become effective trouble-shooters, especially when given ongoing training from experienced AD engineers.

**Tomorrow’s circular organic scenarios**

Organic resources are too valuable to be wasted in landfill. The potential exists to implement smart solutions that integrate the waste, energy and food sectors. Although this would require a change in policy, LEAP has demonstrated that its models can become effective trouble-shooters, especially when given ongoing training from experienced AD engineers.

The plant was housed indoors. Anaerobic digesters typically need to be run at 37-40°C, but the heating required by the plant was far less than normal. The carbon emissions savings were calculated and are broken down in the illustration in Figure 6 [p31]. The largest carbon saving is from the diversion of waste from landfill, followed closely by the production of green energy, which displaces energy from fossil fuels.

**Lessons learned**

Five years into the project, a number of very valuable lessons have been learned from the research carried out:

- Digestate is the single biggest challenge for managing organic waste with AD in the urban context. While this is the case across all scales of AD, cities pose specific challenges with limited growing space and the high value of land. Despite having a number of potential options for digestate deployment, managing the volume produced in real time requires good planning and knowledge of the most effective ways of utilising this valuable by-product.
- User friendliness of micro-AD systems is key to their success.
- Odour is another key issue, which good design can help eliminate. Housing digesters within a structure not only helps minimise heat losses but also keeps odour during operation inside the building. Hygiene protocols also reduce smells and maintaining steady operation of the system makes a difference, as irregular feeding causes instability, which can increase odour generation.
- Good engineering design and training are both critical to the success of a plant. While the technology is relatively simple, it benefits hugely from AD design experience and the operator understanding the process, since mistakes can easily be made without knowledge of the subtle interactions between feedstock, process, design and operation. LEAP has found that its operators can become effective trouble-shooters, especially when given ongoing training from experienced AD engineers.

**References and article available online at:**

Helen Theaker, PhD student, University of Sheffield
Dr Mark Walker, Energy2050 Researcher, University of Sheffield
Rokiah Yaman MA, Director, LEAP micro AD, London

LEAP is looking for partners to help develop this circular organic resource model to achieve both commercial and humanitarian aims. We can provide technical expertise and excellent academic contacts. If you are moving in the same direction and could contribute to the process of realising this vision, do get in touch:

Email: info@communitybydesign.co.uk
Web: www.communitybydesign.co.uk

Tel: 07864 002189
The history of food reformulation

Introduction
The proportion of household income British consumers are currently spending on food and soft drinks is just 15% – less than half the share it took 50 years ago[1]. In the 1960s, foods were literally fuel and concerns about malnutrition were very real. Fifty years on and it can be argued that malnutrition still exists in the UK, with obesity being the major public health concern of our time. Nowadays, consumers seek affordable, convenient and palatable foods and these drivers of food choice can impact negatively on health, with concerns including high blood pressure, raised blood cholesterol and obesity. The health profession has specifically targeted food and milk-based beverages
Milk
Milk is the single most frequently bought grocery item. It is a complex food that has played an important part in the human diet for millennia. Fifty years ago, most consumers received milk daily in 1-pint reusable glass bottles via doorstep delivery. Most of the milk was pasteurised and consumed as whole milk. Pasteurisation of milk can extend the shelf-life from a day to a week with only a slight impact on taste and nutritional content. Today most milk consumed in the UK is still pasteurised but less than 5% reaches consumers via delivery. It is mainly purchased from retailers in various volumes in plastic containers or laminate board cartons. This illustrates the developments in both packaging and control in the distribution chain, which ensure that milk gets to market in temperature-controlled conditions the day after it leaves the cow.
Milk is also available in ambient-stable, flexible laminate packaging following ultra-high temperature (UHT) processing. This technology, pioneered by Tetrapak, has transformed milk and beverage distribution globally. Its introduction followed a breakthrough in carton assembly and aseptic packaging technology in the 1960s. Aseptic processing sterilises the product and the package separately and then combines and seals them in a sterile atmosphere. This is in contrast to canning and bottling, where product and package are first combined and then sterilised. UHT processing has resulted in a dramatic improvement in the flavour quality of milk compared to canned or bottle-stabilised milk, which was the previous ambient format. However, UHT affects...
FOOD REFORMULATION

affecting intake of the essential nutrients present in milk, such as calcium, riboflavin and vitamin B12. Work is underway to further the fat profile of milk by changing the diets of dairy cows and to investigate the health benefits of this approach.

Milk contributes protein, carbohydrate (lactose) and several micronutrients, for example, calcium, which can be lacking in modern diets of some population groups. It can also be a source of iodine, phosphorus and potassium, as well as riboflavin (vitamin B2) and vitamin B12 (Table 3). The nutritional value of milk is in direct contrast to that of sugars-sweetened beverages, as at around 10% sucrose (by volume) they deliver 100% of their energy as sugar with little or none of the additional nutrients.

Milk-based beverages

Using milk as a base for beverages introduces a number of potential health benefits for consumers:
- **Natural**: no colorings or flavorings are added
- **Pure**: pure ingredients used without added sugars
- **Natural**: similar ingredients to regular milk
- **Clean label**: no synthetic compounds and therefore no message of ‘natural’ position.
- **Nutritionally complex**: contains a wide range of nutrients
- **Pure**: pure ingredients used without added sugars
- **Natural**: similar ingredients to regular milk
- **Clean label**: no synthetic compounds and therefore no message of ‘natural’ position.

These milk beverages generally require sweetening and flavouring. The final product may be thick or ambient-stable, so they can be consumed on many occasions. These drinks extend the occasions. These drinks extend the shelf life.

Yogurt is available with a wide range of additional ingredients to milk. These are fortified with probiotics has fallen short of the scientific threshold for a health claim. There is a wealth of evidence to support the clean label credentials of food products, sweeteners, colours, flavourings and hydrocolloid thickeners are moving to a ‘natural’ position. It is thought that less than 10% of yoghurt tends to have a good nutritional profile, recent concerns about the levels of sugars added for sweetening purposes have resulted in many variants using high-potency, low-calorie sweeteners, rather than sugars.

In the middle of the last century cream was a luxury food. Regular yoghurt was also moved from medicinal foods to the mainstream. Technical developments in ingredients and processing have improved the quality and flavour of these products to increase their appeal. It is thought that less than 10% of gluten-free products are purchased by people with coeliac disease and there are concerns that overall dietary balance may be negatively impacted by a gluten-free lifestyle choice. As gluten-free foods can be lower in fibre and certain micronutrients than their regular counterparts.

**FOOD REFORMULATION**

**Table 3: Vitamins and minerals present in 250 ml semi-skimmed milk.**

<table>
<thead>
<tr>
<th>Vitamin</th>
<th>Nutrient Reference Value</th>
<th>250 ml Whole Milk</th>
<th>% Nutrient Reference Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vitamin A (IU)</td>
<td>800 mcg</td>
<td>85 mcg</td>
<td>10</td>
</tr>
<tr>
<td>Vitamin E</td>
<td>12 mg</td>
<td>0.2 mg</td>
<td>10</td>
</tr>
<tr>
<td>Vitamin C</td>
<td>80 mg</td>
<td>5 mg</td>
<td>10</td>
</tr>
<tr>
<td>Thiamine (B1)</td>
<td>1.1 mg</td>
<td>0.7 mg</td>
<td>5</td>
</tr>
<tr>
<td>Riboflavin (B2)</td>
<td>1.4 mg</td>
<td>0.6 mg</td>
<td>5</td>
</tr>
<tr>
<td>Niacin (B3)</td>
<td>16 mg</td>
<td>0.5 mg</td>
<td>10</td>
</tr>
<tr>
<td>Vitamin B6</td>
<td>1.4 mg</td>
<td>0.5 mg</td>
<td>10</td>
</tr>
<tr>
<td>Folic acid (B9)</td>
<td>200 mcg</td>
<td>21 mcg</td>
<td>10</td>
</tr>
<tr>
<td>Vitamin B12</td>
<td>2.5 mcg</td>
<td>2.3 mcg</td>
<td>10</td>
</tr>
<tr>
<td>Biotin</td>
<td>50 mcg</td>
<td>64 mcg</td>
<td>15</td>
</tr>
<tr>
<td>Pantothenic acid</td>
<td>6 mg</td>
<td>1.5 mg</td>
<td>15</td>
</tr>
</tbody>
</table>

**Table 4: Types of milk beverage.**

<table>
<thead>
<tr>
<th>Flavoured milk</th>
<th>Features</th>
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<td>Whose taste was based on its flavour and the eating enjoyment, but for their popularity on yogurt labels. But data have been researching the cultures that live yogurt can be included in the intestine. There are many bioavailability and facilitating uptake points in milk to make it an ideal springboard for a more functional drink, although care must be taken with health claims for such products.</td>
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FOOD REFORMULATION

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are common), there are now reduced sugar options too, sometimes using low/no sugar sweeteners. Given that Public Health England (PHE) has identified yogurts as one of the categories that significantly contribute to children’s sugar intake[13] there is likely to be further focus on this area in the future.

Beverages

are embracing the opportunity to understand. Nowadays, soft

Table 5: High Potency Sweeteners (HPS) providing sugar-free ‘sweetness’

SYNTHETIC

NATURAL ORIGIN

Saccharin

Stevia

Cyclamate

Thaumatin

Aspartame

Glycyrrhizin

Acesulfame-K

Honey Guo/Monk fruit

Saccharin-acesulfame salt

Neohesperidin dihydrochalcone

Steviol

Advan甜art

SOFT DRINKS

in the 1960s, carbonated beverages were available in glass bottles that were returned by the consumer and reused by the manufacturers. Drinks were sugars-sweetened and the carbonation was achieved by the use of carbon dioxide gas.

few health benefits are supported by approved health claims. Where claims are made, they usually relate to nutrition content e.g. vitamin C.

More than any other type of food, fruit benefits from being consumed in its natural state, i.e. fresh. With fresh fruit, the “real” benefits are retained, whereas with processed fruit, the nutrients and health benefits are often lost.

In the 1960s, carbonated beverages were available in glass bottles that were returned by the consumer and reused by the manufacturers. Drinks were sugars-sweetened and the carbonation was achieved by the use of carbon dioxide gas.

Nowadays, sugars-sweetened carbonated beverages are an everyday item but have been subject to extensive criticism due to their high sugar content without additional nutrition, which has been linked to poor dental health and overweight and obesity conditions. Most soft drinks reflect the sweetness of fruit, i.e. about 10% and a 330ml can contains about 8 teaspoons of sugar and 132 kcal/556 kJ.

Sugars in most formulated soft drinks primarily provide sweetness and, of course, energy. HPS have found wide-spread application in soft drinks, where they provide sweetness without adding calories. HPS are much sweeter than sucrose on a gram for gram basis (50–10,000 times sweeter), so very little is needed to achieve the desired sweetness level. They also vary in their quality and stability. Most HPS are not metabolised and therefore contribute no calories to the diet.

The number of natural HPS currently available is limited and their use is highly regulated; for example, Thaumatin and glycyrrhizin are better described as flavour modifiers than sweeteners. Le han guo or monk fruit is approved for use in a number of territories, but not the EU. Stevia’s use is more widely permitted but limited by category and use level in the EU[13]. EU regulations require a 30% calorie reduction as a minimum for the use of HPS[12], but, in practice, 50% or high potency sweeteners (HPS) of quality available and in case any sugar concentration was not the concern it is today.

Technologies developed for alternative, dispersible packaging of these beverages helped these to become more available and affordable. The aluminum can started to replace the traditional 1960s and moulded PET bottles by the late 1960s. These were lighter, higher and less breakable, compared to glass and today almost 50% of the beverage is made to taste like the juice that makes the appropriate choice for the health of children.

However, market success depends not only on flavour quality and palatability of the alternative beverage product, but marketing position and ingredient use. The HPS that are effective in sugar-free beverages in synthetic and some consumers want only natural ingredients in their foods. Currently no permitted ‘naturally derived’ HPS can deliver the full sweetness quality as a full sugar version.

Bread

Historically, bread was unleavened, much like today’s Indian chapattis, as there were no raising agents and it was made from available grains. In times of yeast, doughs developed and wheat became the grain of choice, miling the wheat allowed the production of white bread. Ear early civilisations, white flour became synonymous with refinement and was highly desirable, a situation that for many still exists today. Although the ability to make sliced bread was pioneered in the US in the early 20th Century, the war years saw the importation of the National Loaf, which was withdrawn in 1956. As bread was an important staple, it was around this time that laws were introduced requiring all flour other than wholemeal to be fortified with calcium, iron, vitamin B1 (thiamin) and nicotinic acid.

The Chorleywood Bread Process (CBP), developed in 1961 by the British Baking Industries Research Association, revolutionised bread making in the UK. It started to impact the industry in the mid-60s. Compared to the older bulk fermentation process, CBP is quicker, reduces the use of raising agents. The industry has learnt to manage the significant flavour differences between a sugars-sweetened beverage and one sweetened with HPS to offer consumers palatable sugar-free/calorie-free/no added sugar products.

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Bread had achieved a level of quality, affordability and convenience that could not have been envisaged just 20 years before and it remains a staple of most UK diets and an important contributor to our nutritional status.

However, more recently, it has been recognised that bread, typically white, loaves may not be providing an optimal combination of nutrients. Given that bread is such a staple, any ingredients that are out of step with recommendations can have a major impact on the overall diet. Hence bread, salt and to a lesser extent, fibre consumption is intrinsically linked.

The CDMA (Committee on Medical Aspects of Food) report of 1999[14] was the first Government report to make recommendations on salt reduction proposing A reduction in the average intake of common salt (sodium chloride) by the adult population from the current level of about 9g/day to about 6g/day. This would require more salt reduction in the global trading and processing of food manufacturers, caterers and individuals. The recommendation was followed by the Health and Nutrition Education Bureau of the Ministry of Health, Labour, and Welfare of Japan, the National Nutrition Campaign, and the Food Technology Committee of the Ministry of Agriculture, Forestry and Fisheries. In 2000, the new restrictions on salt intake to blood pressure, a risk factor for cardiovascular disease. It was followed by the SACN (Scientific Advisory Committee on Nutrition) report of 2003[18], in which the target consumption of 6g/day was confirmed and there was a specific recommendation to reformulate foods that were identified as contributors to salt consumption.

Cereal and cereal products, which includes bread, rolls, pasta and rice, biscuits, cakes and pastries, were shown to be the biggest contributor of salt to the diet in England (60% and 37.7% of the total intake as measured by the DEFRA National Food Survey (2003)[19].

A series of targets for different food categories were set over the next few years, initially by the Food Standards Agency (FSA) and then by the Department of Health, as nutrition policy moved from one organisation to another. In 2013, the FSA published voluntary salt reduction targets to encourage a reduction in the salt content in household salt in a wide range of processed

FOOD REFORMULATION

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FOOD REFORMULATION

Helen Munday was Director of Scientific and Regulatory Affairs for Coca-Cola from Flavour Horizons, Maidenhead, UK London, WC1A 2SL. Email helen.munday@fdf.org.uk

The food industry and regulators agree that the choices we have today have never been greater. Food science will continue to strive for safe, affordable, tasty and nutritious food for all.

Government policy guidelines, this also drives reformulation. The current PHE recommendations on sugar reductions aim to reduce the amount of sugar in foods that contribute most to children’s intakes of sugars, such as breakfast cereals and yogurts. The aspiration is to reduce the sugar in these foods by 20% by 2020, with a 5% reduction in the first year (2017) and this will require further reformulation work. Alongside this reformulation, there have been other enabling developments in ingredients, processing and packaging. For example, salt reductions would not have been possible without adaptions to other elements of the product, such as controlled atmosphere packaging or alternative ingredients that maintain shelf-life.

Salt was originally used as a preservative and when removing it, adjustments to other ingredients are necessary. New HPS, including naturally derived sweeteners from stevia leaves, are being introduced to support sugar reduction in soft drinks and beverages while maintaining sweetness and cost. Novel fibres and alternative protein and carbohydrate sources have all added to reformulation options with improved nutrient profiles.

Whilst consumers might not automatically choose foods that make up a balanced diet, food science and reformulation have improved the nutrient profiles in the nutritional value of everyday foods. The changes in food science are often so significant that when go unnoticed, but most people will agree that the choices we have today have never been greater. Food science will continue to strive for safe, affordable, tasty and nutritious food for all.

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Introduction

A choking episode can be one of the most frightening experiences for any parent or carer, as the body respiration continues to a common paediatric problem, with food a major cause, especially in the under-fives, the main at-risk population. A second incidence peak typically occurs in the age range 8–11 years, when more non-feed items are implicated. Although many choking episodes resolve spontaneously, when they do not, the consequences can be severe – from immediate death to brain injury owing to hypoxia[1]. A typical incident in the media illustrates the tragic consequences. Toddler Adam Milner died in 2009 after choking on a piece of chipolata sausage, with his parents making recommendations in 2010 for any parent or carer. Foreign items are implicated. Although food a major cause, especially in children, guidance is preferred to address choking risks but safety legislation and standards are developed work flow (Table 2). LGC has developed a battery of tests to assess whether jelly confectionery is reinforced in Part E of Annex II, which also provides the definition of a jelly mini-cup: The substances listed under numbers E 400, E 401, E 402, E 403, E 404, E 406, E 407, E 407A, E 410, E 412, E 413, E 414, E 415, E 417, E 418, E 425 and E 440 may not be used in jelly mini-cups, defined, for the purpose of this Regulation, as jelly confectionary of a firm consistence, contained in semi rigid mini-cups or mini-capsules, intended to be ingested in a single bite by exerting pressure on the mini-cups or mini-capsules to project the confectionary into the mouth. E 410, E 412, E 415 E 417 may not be used to produce dehydrated foods intended to rehydrate on ingestion. E425 may not be used in jelly confectionary.

Difficulties with the definition

Although at first sight the definition of a jelly mini-cup seems straightforward, it contains several elements that pose difficulties. What does ‘firm consistence’ mean? And how can we interpret ‘intended to be ingested in a single bite…’? No further guidance has been issued by the European Commission or the Food Standards Agency.

In the UK, the Government Chemist is required to act as the national focus of technical appeal where there is an actual or potential dispute between food businesses and regulators in the agrifood sector. The Laboratory of the Government Chemist (LGC) was involved in the original work for EFSA in 2004 on jelly mini-cups. Since then, disputes in this area and calls for food advice from food businesses and regulators have been a regular feature of our work. This led us to publish a paper in 2012 setting out how we approach the issues[2]. The paper remains the only publicly available advice on jelly mini-cups and is regularly used by Public Analysts and trade laboratories to assess submitted samples.

Technical appeals follow a well-developed work flow (Table 2). LGC has developed a battery of tests to assess whether jelly confectionary

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TABLE 2: TYPICAL STEPS IN A GOVERNMENT CHEMIST TECHNICAL SUPPORT DISPUTE CASE

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Decision to accept, and appropriate funding contribution</td>
</tr>
<tr>
<td>2</td>
<td>Scientific and administrative case meeting to identify appropriate techniques and methods, and schedule work</td>
</tr>
<tr>
<td>3</td>
<td>Appropriate legislation identified and checked</td>
</tr>
<tr>
<td>4</td>
<td>Methodology investigated, if necessary modified</td>
</tr>
<tr>
<td>5</td>
<td>Experimental work, multiple replicates on multiple days, any spikes, all key steps re-reviewed if necessary</td>
</tr>
<tr>
<td>6</td>
<td>Data compiled and all data transcriptions checked</td>
</tr>
<tr>
<td>7</td>
<td>Results reviewed against quality criteria</td>
</tr>
<tr>
<td>8</td>
<td>Batches repeated or new analytical runs if required</td>
</tr>
<tr>
<td>9</td>
<td>Statistics review datasets for outliers, batch effects, and case-specific measurement uncertainties calculated as appropriate</td>
</tr>
<tr>
<td>10</td>
<td>Results interpretation</td>
</tr>
<tr>
<td>11</td>
<td>Certificate drafted, reviewed &amp; data independently checked</td>
</tr>
<tr>
<td>12</td>
<td>Formal case review meeting with Government Chemist, for examination of case file, queries addressed, appropriate steps repeated if required and re-review if necessary</td>
</tr>
<tr>
<td>13</td>
<td>Certificate (official report typically 3000-3000 words) released to the immediate parties concerned</td>
</tr>
</tbody>
</table>

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Flavourings, Enzymes and Extraction Solvents Regulations 2013, made separately in each of the home countries, lists the food additives approved for use in foods and their conditions of use. Part C contains the relevant listed additives each with an attached condition reading ‘May not be used in jelly mini-cups’. The prohibition of the relevant additives in jelly mini-cups is reinforced in Part E of Annex II, which also provides the definition of a jelly mini-cup: The substances listed under numbers E 400, E 401, E 402, E 403, E 404, E 406, E 407, E 407A, E 410, E 412, E 413, E 414, E 415, E 417, E 418, E 425, E 440 may not be used in jelly mini-cups, defined, for the purpose of this Regulation, as jelly confectionary of a firm consistence, contained in semi rigid mini-cups or mini-capsules, intended to be ingested in a single bite by exerting pressure on the mini-cups or mini-capsules to project the confectionary into the mouth. E 410, E 412, E 415 E 417 may not be used to produce dehydrated foods intended to rehydrate on ingestion. E425 may not be used in jelly confectionary.

Difficulties with the definition

Although at first sight the definition of a jelly mini-cup seems straightforward, it contains several elements that pose difficulties. What does ‘firm consistence’ mean? And how can we interpret ‘intended to be ingested in a single bite…’? No further guidance has been issued by the European Commission or the Food Standards Agency.

In the UK, the Government Chemist is required to act as the national focus of technical appeal where there is an actual or potential dispute between food businesses and regulators in the food and drug sector. The Laboratory of the Government Chemist (LGC) was involved in the original work for EFSA in 2004 on jelly mini-cups. Since then, disputes in this area and calls for food advice from food businesses and regulators have been a regular feature of our work. This led us to publish a paper in 2012 setting out how we approach the issues[2]. The paper remains the only publicly available advice on jelly mini-cups and is regularly used by Public Analysts and trade laboratories to assess submitted samples.

Technical appeals follow a well-developed work flow (Table 2). LGC has developed a battery of tests to assess whether jelly confectionary

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TABLE 2: TYPICAL STEPS IN A GOVERNMENT CHEMIST TECHNICAL SUPPORT DISPUTE CASE

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Decision to accept, and appropriate funding contribution</td>
</tr>
<tr>
<td>2</td>
<td>Scientific and administrative case meeting to identify appropriate techniques and methods, and schedule work</td>
</tr>
<tr>
<td>3</td>
<td>Appropriate legislation identified and checked</td>
</tr>
<tr>
<td>4</td>
<td>Methodology investigated, if necessary modified</td>
</tr>
<tr>
<td>5</td>
<td>Experimental work, multiple replicates on multiple days, any spikes, all key steps re-reviewed if necessary</td>
</tr>
<tr>
<td>6</td>
<td>Data compiled and all data transcriptions checked</td>
</tr>
<tr>
<td>7</td>
<td>Results reviewed against quality criteria</td>
</tr>
<tr>
<td>8</td>
<td>Batches repeated or new analytical runs if required</td>
</tr>
<tr>
<td>9</td>
<td>Statistics review datasets for outliers, batch effects, and case-specific measurement uncertainties calculated as appropriate</td>
</tr>
<tr>
<td>10</td>
<td>Results interpretation</td>
</tr>
<tr>
<td>11</td>
<td>Certificate drafted, reviewed &amp; data independently checked</td>
</tr>
<tr>
<td>12</td>
<td>Formal case review meeting with Government Chemist, for examination of case file, queries addressed, appropriate steps repeated if required and re-review if necessary</td>
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</table>
CHOKING HAZARDS

Gel-forming additives

The presence or absence of gel-forming additives listed in the definition is usually a matter of agreement between the parties based on the specific specification and ingredients list.

Physical characteristics of the product

The physical characteristics are important to the definition and the potential of the product to represent a choking risk.

In the laboratory, the products are described, photographed, weighed, measured and tested for size in relation to a “Small Parts Cylinder” (SPC) (Figure 2). The SPC originates from the American Code of Federal Regulations, CFR Title 16, Part 1000, 1581 and is included in the toy standard EN71-1 to ensure toys and toy components have a minimum size to avoid the hazards of asphyxiation and choking as described in the section on particular safety requirements in the European Directive 2009/48/EC on the safety of toys. Toy items, which fit completely within the SPC without the application of pressure, are deemed not suitable for children less than 3 years of age. The dimensions of the SPC mimic those of a child’s mouth and pharynx. However, containment or otherwise within the SPC is a grey area and a definitive aspect in assessing size and shape in relation to choking risk.

When introduced tip first, some products fit into the SPC but not when introduced base first. The slippery nature of some products and their cone shape might lodge one in the human airway if it went down the throat tip first. But clearly if a product is too large to fit at all into the SPC, it is unlikely to present a choking risk.

The behaviour under compression and when bitten into are telling characteristics. Thus, items are tested using a Hounsfield H10K-5 Materials Testing Instrument. The data obtained includes the force required to penetrate the end seal of the products and the jellyies themselves with a tooth-shaped indentor (Figure 3). How the products behave under compression with a flat surfaced disc is also investigated. The konjac material originally used in jellyies was very hard, some requiring forces up to 170 Newtons to penetrate. By way of comparison, the maximum mean vertical biting forces for children 18 months of age are 111 N, rising to 222 N for children 36 months of age and 445 N for children 3-8 years of age. Non-konjac products can be penetrated with forces much less than 1 N. Many of the products we examine simply squeeze out from under the flat disc at forces around 30 N without appreciable damage or distortion, something that goes towards the assessment of firmness (Figure 4).

Solubility characteristics

Solubility is another key characteristic. If the jelly confectionery does not dissolve quickly and becomes lodged in the airway, bronchospasm or laryngospasm may be induced, exacerbating the possibility of asphyxiation.

Thus, the products are tested for solubility by immersion in artificial saliva at 37°C for 5 minutes (Figure 5). But reasonably foreseeable use should also be taken into account, e.g. the unpredictable behaviour of children. The European Commission’s view on labelling at the time the legislation on jelly mini-cups was introduced was that safety labelling is not enough to protect children’s health.

The four questions

In the final assessment four questions need to be addressed:

1. Are the products jelly confectionery?
2. Are the products in semi rigid mini-cups or mini-capsules? Again, this is usually self-evident.
3. Are the products intended to be ingested in a single bite by exerting pressure on the mini-cups to project the confectionery into the mouth? This aspect depends on the size, shape and packaging. For most products, the pressures required to eject the product from its container without separately breaking the end seal are too great to be exerted by children.
4. Do the products have a firm consistency?

This is really the crux of the problem. The indenter, compression and solubility characteristics must all be considered. LGC views ‘firm’ as representing a choking risk either (i) by being hard, so that it requires considerable force to bite into (the original konjac products) or (b) not being readily disrupted or brought into solution by saliva (or its simulants) in a time of two minutes.

Although there are some instances of people surviving hypoxia for longer periods of time, the two-minute limit was decided in the light of medical advice and in discussion with a forensic pathologist with experience of choking fatalities.

Conclusions

Many food items are capable of choking if accidently aspirated into the airway. Most such events resolve spontaneously, but some have tragic consequences.

Only jelly mini-cups have attracted the attention of European legislators and in some instances the courts, where in the US, substantial damages have been awarded against firms that sold jelly mini-cups that resulted in the death of children.

The tests developed should be applied with the question of whether or not any particular product conforms to the legal definition of ‘a jelly mini-cup’. If a product conforms to the definition and contains any of the banned gel-forming additives, it is non-compliant and constitutes a choking risk.

Importers, in particular, are recommended to ensure representative samples of any conignment destined for the UK are forwarded in advance of shipping for testing in the UK by a laboratory familiar with the tests described.

Further experimental details are included in our 2012 paper, which is currently being updated. LGC would welcome any comments from readers of F&S.

References and article available online at: www.fstjournal.org/features/31-3/choking-hazards

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Tel +44 (0) 289096 8732
Web https://www.gov.uk/government/organisations/government-chemist
Food labelling beyond EU borders

Sarah Howarth looks at the contribution of UK food and drink products to overseas trade. She considers some of the export challenges facing the UK after Brexit with a focus on the CODEX food labelling standards.

Food and drink exports and imports

In the wake of Brexit, many more businesses are seeing export opportunities to grow beyond EU borders. Currently the UK is a net importer of food and drink, estimated to be just under 80% self-sufficient. Total exports to the EU stood at 47% in May 2017. Over the past 18 months, the amount exported to the EU has ranged from 38% to 51% with UK imports over the same period ranging between 44% and 56% [1]. Let us not get into the argument of who needs who most. During 2015, food and drink contributed just under 4% of total export trade. Table 1 shows the top 10 food and drink products exported from the UK with whiskey appearing a clearer leader[2]. Many of these items appear to be premium and high value with a stable shelf life. It is surprising that food and drink appears to be such a low overall contributor to total export trade. In their everyday lives, consumers often take for granted that many of the products they use on a daily basis are not made in the UK. Why are food and drink export levels so low from the UK's largest manufacturing sector?

One of the key challenges is clear product presentation that meets market regulation and standards as well as being appealing to the consumer. The food label is often the primary source of communication between the producer and consumer at the point of sale. As the UK seeks to increase its export trade beyond EU borders, the global foundation for food labelling, CODEX Food labelling guidelines[3], will become increasingly important by comparison with the more familiar EU FIC Regulation for food labelling.

CODEX Food Labelling guidelines

The CODEX guidelines are published as a reference to safeguard public health whilst facilitating free trade at a global level. The fifth edition of CODEX Food Labelling guide includes sections on: • Pre-packaged goods • Food Additives, when sold as such • Claims on pre-packaged goods for special dietary uses • Guidelines on claims • Nutritional labelling • Use of Nutrition and Health claims • Use of the term ‘halal’

The EU FIC Regulation predominantly applies to pre-packed foods that bear labels, so it is useful to explore further the implications of CODEX for UK food manufacturers of pre-packed foods wishing to trade outside the EU. General standard for the labelling of pre-packed foods (CODEX STAN-1985)

Table 2 shows the mandatory information that must be present on the label according to CODEX STAN-1985 and EU FIC. Bearing in mind that the CODEX STAN-1985 section on pre-packaged foods consists of 10 pages and the EU FIC Regulation is 64 pages, the table is very much a summary highlighting additional CODEX requirements. By sheer volume of paper, it is clear that the EU regulation is significantly more prescriptive in its approach.

Much of the 10-page CODEX document has been incorporated into the current European regulation, with the few exceptions detailed in Table 2. Standard for nutritional labelling on pre-packed foods (CODEX CAC/GL-2/1985)

Nutritional labelling on pre-packed foods (CODEX guidelines on nutritional labelling CAC/GL-2/1985) became a mandatory requirement in December 2016. A comparison with the EU regulation is included in Table 3.

Table 1 Top 10 food and drink products exported from the UK in 2015

<table>
<thead>
<tr>
<th>Product</th>
<th>2015 (m)</th>
<th>2016 (m)</th>
<th>Change</th>
<th>% Value</th>
<th>% Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whisky</td>
<td>£4095.3</td>
<td>£89.1</td>
<td>-</td>
<td>17.8%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Chocolate</td>
<td>£663.4</td>
<td>£53.0</td>
<td>-</td>
<td>13.5%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Beer</td>
<td>£595.4</td>
<td>£89.1</td>
<td>-</td>
<td>17.8%</td>
<td>10.0%</td>
</tr>
<tr>
<td>Salmon</td>
<td>£579.2</td>
<td>£81.7</td>
<td>-</td>
<td>16.4%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Cheese</td>
<td>£498.8</td>
<td>£49.4</td>
<td>-</td>
<td>11.0%</td>
<td>7.7%</td>
</tr>
<tr>
<td>Wine</td>
<td>£490.1</td>
<td>£49.6</td>
<td>-</td>
<td>11.2%</td>
<td>-14.0%</td>
</tr>
<tr>
<td>Gin</td>
<td>£475.0</td>
<td>£53.0</td>
<td>-</td>
<td>12.9%</td>
<td>10.6%</td>
</tr>
<tr>
<td>Beef</td>
<td>£446.8</td>
<td>£16.8</td>
<td>-</td>
<td>3.9%</td>
<td>1.4%</td>
</tr>
<tr>
<td>Soft drinks</td>
<td>£427.8</td>
<td>£47.7</td>
<td>-</td>
<td>12.6%</td>
<td>9.6%</td>
</tr>
<tr>
<td>Wheat</td>
<td>£569.2</td>
<td>£123.9</td>
<td>-</td>
<td>46.7%</td>
<td>-49.2%</td>
</tr>
</tbody>
</table>

Table 2 Comparison of mandatory information that must be present on the label between CODEX STAN-1985 and EU FIC

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Name of the food</td>
<td>☑</td>
<td>☑</td>
<td>CODEX states that where a name/names have been established for a food standard at least one of these names shall be used.</td>
</tr>
<tr>
<td>List of ingredients</td>
<td>☑</td>
<td>☑</td>
<td>CODEX does not require compound ingredients to give a breakdown when less than 5% in the product. This does not include additives with a technological function in the product. NOTE. EU FIC Regulation Annex VII Part E does not require a breakdown (less than 2% this does not apply to food additives).</td>
</tr>
<tr>
<td>Allergens</td>
<td>☑</td>
<td>☑</td>
<td>CODEX: There are 9 which need to be declared. EU FIC Regulation Annex II There are 14 adding Molluscs, Lupin, Sesame, Mustard, Celery</td>
</tr>
<tr>
<td>Added water</td>
<td>☑</td>
<td>☑</td>
<td>CODEX: Added water must be declared as an ingredient unless it forms part of an ingredient such as brine, syrup or broth used in a compound ingredient need not be declared. EU FIC Regulation Annex VII added water above 5% in the finished product must be declared, excluding meat and fish products.</td>
</tr>
<tr>
<td>Refined fats and oils other than olive</td>
<td>☑</td>
<td>☑</td>
<td>CODEX: Does not require specific origin to be declared unlike EU FIC Regulation Annex VII Part A with the exception of pork fat, tallow and beef fat.</td>
</tr>
</tbody>
</table>

Food and drink products to overseas trade. She considers some of the export challenges facing the UK after Brexit with a focus on the CODEX food labelling standards.

Table 1 Top 10 food and drink products exported from the UK in 2015

<table>
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<tr>
<th>Rank</th>
<th>Product</th>
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<tr>
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<td>Beer</td>
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</tr>
<tr>
<td>4</td>
<td>Salmon</td>
<td>£579.2</td>
<td>16.4%</td>
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</tr>
<tr>
<td>5</td>
<td>Cheese</td>
<td>£498.8</td>
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</tr>
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<tr>
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</tr>
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<td>10</td>
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</tr>
</tbody>
</table>

www.fstjournal.org
As with the CODEX standard for pre-packaged foods, much of the CODEX nutritional labelling guidelines has been adopted into the familiar EU FIC regulation.

**Conclusions**

As technical managers, it is very easy to become UK centric and rely on the information sources close to home, which have become familiar. CODEX standards and specifications can often be a helpful starting point in the hierarchy of food safety standards and regulations.

Life might be simpler if we all followed the CODEX food label, but we are well beyond that stage and there is no turning back. The EU FIC Regulation has already evolved and extends to 63 pages. The global trend appears to be a move toward mandatory nutrition labelling. The Codex guidelines were amended in 2012 to recommend that nutrition labelling should become mandatory, even in the absence of health claims. Many countries that had a voluntary approach to nutrition labelling have in recent years adopted measures to make this mandatory.

Businesses seeking to grow through export trade should be sure to check that they meet the food safety standards and regulations for the destination market. CODEX is often a useful starting point followed by the specific country rules. It is important to check who is responsible for what, with written terms for clarification to help avoid nasty surprises and expensive border delays.

<table>
<thead>
<tr>
<th>LABEL INFORMATION</th>
<th>CODEX: Voluntary on pack</th>
<th>EU FIC REGULATORY REQUIREMENT?</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mandatory nutritional information when making a Health Claim</td>
<td>✔</td>
<td>✔</td>
<td>CODEX: Voluntary on pack</td>
</tr>
<tr>
<td>Mandatory nutritional information on pack</td>
<td>✗</td>
<td>✔</td>
<td></td>
</tr>
<tr>
<td>Guidelines for the nutritional information</td>
<td>✔</td>
<td>✔</td>
<td>EU FIC Regulation Annex XV</td>
</tr>
<tr>
<td>Vitamin and mineral declarations</td>
<td>✔</td>
<td>✔</td>
<td>CODEX: Amounts less than 5% NRV per 100g/100ml cannot be declared. EU FIC Regulation Annex XIII higher levels of % RNI must be present to allow declaration on pack: 15% RNI foods; 7.5% beverages per 100g/100ml</td>
</tr>
</tbody>
</table>

**CODEX standards and specifications can often be a helpful starting point in the hierarchy of food safety standards and regulations.**

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Sarah Howarth BSc Hons, C Sci, FIFST, member of IFST Scientific Committee, is an experienced food professional with 30+ years’ experience within the food industry. After having worked for a number of international companies including Unilever, Yum Brands (Pizza Hut; KFC), Cargill, Cott Corporation and Marks & Spencer, she set up independently to support companies with their Food Safety Compliance. She has a keen interest in food and drink labelling, supporting local, national and international companies with labelling compliance advice. Sarah is a member of the SALSA food labelling course development and delivery team.

Email: sarah.howarth@howarthfoodsafety.co.uk
Web: http://www.howarthfoodsafety.co.uk/index.php

**References and article available online at:**

www.fstjournal.org/features/31-3/food-labelling

Lab Innovations is the UK’s only exhibition dedicated to the laboratory industry. This is your opportunity to:

- Discover the latest innovations in laboratory technology, biotech and analytical equipment, from over 130 manufacturers and suppliers of laboratory products
- Network and build new relationships with key industry peers
- Get access to over 30 hours of seminar content designed to discuss the latest hot topics in the industry and delivered by industry experts such as the Royal Society of Chemistry
Sensors break out of the lab

Isabel Hoffman, Mark Bloore, Behafarid Darvish and Zoltan Kovacs of Canada and UK-based Tellspec describe a new, miniaturised food sensor able to detect compounds in food at a molecular level. They explain the potential of the sensor for detecting melamine adulteration of foods.

**Spectral analysis**

Spectral analysis is a standard technique for discovering the chemical composition of substances. Different parts of the spectrum are suited to different types of analysis. The near-infrared (NIR) spectrum is particularly good for studying organic substances, because it responds to bonds between their different types of atoms and thus to the makeup of entire molecules.

A spectrum is obtained by shining NIR light onto a sample and recording the intensity of reflected light at each wavelength in the NIR range. Different atomic bonds will absorb light at different wavelengths and by different amounts creating a pattern, which can be examined for data on the bonds present in a sample. Until recently, this type of analysis had to be performed in a laboratory with large and expensive equipment to get spectra of adequate quality. However, in 2014, Canada and UK-based Tellspec designed a new sensing system that combines a hand-held miniature NIR spectrometer with a smartphone linked to a cloud-based collection of machine-learning algorithms that can be trained to detect compounds, such as adulterants and contaminants in foods, at a molecular level.

**Rapid, mobile food sensing**

The internal light source in the miniaturized sensor focuses a beam of light through the front window into the food. Light reflected from the sample is then collected through the same window. This light is dispersed onto a micro-mirror device and measured by an optimised detection system. A digital electronic spectrum is produced, characteristic of the composition of the food. The digitised spectrum of the food is transmitted wirelessly from the scanner to the Tellspec analysis engine in the cloud. The algorithms analyse the spectrum for information about the food and send the results back to a smartphone in seconds. A combination of machine learning, bioinformatics techniques and traditional spectroscopy provides the ability to extract nutritional information from a spectrum, the unique fingerprint of the food.

**Detecting melamine in infant formula**

In 2008 there was an infamous incident of infant formula adulteration in China with the industrial chemical melamine. This allowed producers to dilute the formula but keep it passing protein-content tests. At least six infants died of kidney failure and tens of thousands were sickened. That was not the first incident. Even today, pet foods, livestock feed and commercial flour shipments are found with added melamine. There is a strong need for quick and easy detection of such adulteration at all levels in the food chain.

Melamine has a characteristic spectrum in near-infrared light (Figure 2), due in part to the many nitrogen-hydrogen bonds present. This allows producers to add melamine to the formula before or after it was dried, without adding any visible changes to the formula. A detection method must be able to recognise adulterated infant formula spectrum.

A combination of machine learning, bioinformatics techniques and traditional spectroscopy provides the ability to extract nutritional information from a spectrum.

In addition to the obvious series of peaks, there are subtler features present, which are still significant. Mixing with other substances alters all of these features and may overlay them with the spectra of other substances (Figure 2).

Machine learning provides a powerful array of techniques for finding spectral features that distinguish the melamine signature within the complex mix of substances found in any usual foodstuff.

Complicating the detection of melamine in powdered infant formula is the fact that the spectra are different depending on whether the melamine was mixed into the formula before or after it was dried to powder. The melamine signature is less prominent when it is mixed into liquid formula. A detection method must be able to recognise...
Validation testing

Different infant formulas were contaminated with various doses of melamine (0-10%) and samples were scanned with TellSpec Enterprise Food Scanners. Spectra were recorded in the 900-1700 nm interval, with 2nm spectral step. Partial least squares regression (PLSR) was used for quantitative models to evaluate the relationship between the melamine concentration and NIR spectra. The PLSR models were optimised with cross-validation, where data of single samples with their repeats were left out of the calibration and were used for validation, iteratively. Average absorbance spectrum of melamine shows peaks at 1021, 1473, 1494 and 1522nm (Figure 3), which is in line with results obtained by other researchers[1].

The accuracy of the results obtained was assessed by using statistical algorithms for validation. A high coefficient of determination (R2) was found in validation. A high coefficient of using statistical algorithms for obtaining was assessed by the accuracy of the built model with melamine in samples indicating newly-prepared samples, closely up to a concentration of 18%

Conclusions

The hand-held food scanner can warn consumers, as well as commercial buyers, of melamine adulteration in infant formula, flour and gluten supplies, pet foods and any other foodstuff that might benefit from a seeming boost in protein content. This has already been demonstrated for powdered infant formula. It could be a useful tool for users, buyers, inspectors and regulators for rapid melamine detection. It offers the potential for manufacturers to prevent contamination of their products, regulators to track contamination to its source and consumers to be confident in the quality of their food.

References and article available online at: www.ifstjournal.org/features/31-3/detecting-melamine

Isabel Hoffman, founder and CEO, Mark Bloor, Behafarid Darvish and Zoltan Kovacs
TellSpec, 7B Pleasant Blvd, Suite 991, Toronto, Ontario, Canada M4T 1K2
Email info@tellspec.com Web http://tellspec.com
The University of Leeds Food Science Summer School is held every year, with space for approximately 30 Year 12 attendees studying appropriate science A Levels, such as Biology, Chemistry, Physics or Maths, and with a commitment to studying a science-related subject at university. The three-day Widening Participation event was sponsored by the CFA (Chilled Food Association) and the IGD (an education and training charity for the food and grocery industry that undertakes research for the benefit of the public) to promote work and study within the food and drink sector in the UK. It is crucial for the School to continue to recruit and train food scientists for the future.

The Food Science two-night, residential Summer School took place on 27th – 29th June and aimed to give an introduction to higher education and university life.

Joanne Burke describes the aims of the recent Food Science Summer School at the University of Leeds and the activities undertaken by participants.

Programme

The programme was specifically designed to encourage an interest in Food Science & Nutrition and incorporated taster labs, where attendees were able to investigate product design, use analytical techniques to understand the properties of food, attend industry visits and receive an introduction to higher education and university life in general.

The first task the attendees were given was to investigate the benefits of smoothies and the challenges faced in new product development. They were given a brief to develop a smoothie that both tasted and looked good but that could also reduce blood pressure. They took on the task and created some innovative products to showcase. The winning team used beetroot as the main ingredient to reduce blood pressure. They took it into account that it could also reduce blood pressure and used berries to create a palatable taste.

The creative lab sessions continued with attendees exploring the difficulty of making a ‘melt in the middle’ pudding and blind taste testing against other leading brands so they could understand difficulties that occur in the processing stage. Attendees participated in several other projects in the lab to explore the crucial health demands of food, including understanding the structure complexity of ice cream, manipulating properties of protein, difficulties of managing iron in food and the effects of pH on food colours. They also considered the effects these elements can have on health.

To add to the research and laboratory sessions, attendees were taken on an industry visit so they could understand how the issues addressed in the Summer School play out in the ‘real world.’ They visited Taylors of Harrogate, a Yorkshire family business that addressed many societal challenges affecting everyone on a daily basis.

Joanne Burke describes the aims of the recent Food Science Summer School at the University of Leeds and the activities undertaken by participants.

Feedback from attendees

I gained a lot of information about food science and it has given me an idea as to what kind of careers I can go into with my degree. One of the most interesting things was speaking to current and past students about their experiences at Leeds University, which was extremely useful. My favourite activity was definitely visiting Taylor’s of Harrogate, as it showed me how many possible careers there actually are within the food industry.

I’m very satisfied about this whole summer school programme. The staff who came to help out were all amazing and deserve our gratitude for taking good care of us. It’s been a pleasure to partake in these numerous activities.

Career and training in the food and drink sector
In-depth learning from industry placement

As part of my undergraduate course at Abertay University (BSc (Hons) Food and Consumer Science) I undertook a 10-week work placement in the food industry. My main aims were to improve my confidence to work independently, to have an opportunity to be involved in the development of new products using the theoretical knowledge and practical skills that I have gained during the NPD module at University and to gain practical experience in applying knowledge and academic skills for food safety and quality.

I was placed in a small family bakery in Perth, Scotland that manufactures a variety of products including bread, rolls, cream cakes, confectionary products and biscuits.

My role within the organisation was to assist the Technical Manager with the day-to-day tasks including the daily quality assurance checks. I had to ensure that all the received products were booked in the traceability system and the paperwork was collected and filed. Moreover, I worked on a project for updating the current food safety management system, as well as assisting in the development of a new system based on the SALSA standard for a sister bakery in Aberdeen, including the setup of pre-requisite programmes and HACCP.

I was also involved in the steps for setting up a new product, including how to create a specification and what is necessary for the product to be approved and sold in one of the biggest retailers in the UK. I attended meetings, audits and food safety training sessions.

Another project was to create an Audit Plan for the bakery shops that are located within Perthshire. I assisted the technical manager in auditing the first one and was then given the opportunity to audit the rest and to create written reports on the shop food safety and hygiene performance.

My passion for food safety and quality drove me to take all the opportunities I was offered to increase my knowledge. Every day I learned something new.

I really enjoyed all the activities especially the ‘smoothie challenge’. I met some really nice people, both the students on the course and the staff. I really enjoyed all the activities especially the ‘smoothie challenge’. The fact that we were grouped differently for each activity made it much easier to get to know a wide variety of people on the course and find friends. I also really enjoyed the trip to the tea factory as it gave the summer course some diversity. I also found it really interesting as my family has a background within the tea industry.

Every day I learned something new.

References and article available online at: www.fstjournal.org/features/31-3/careers-training/summer-school

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Email: J.Burke@leeds.ac.uk
Web: www.food.leeds.ac.uk/home/schools-outreach/summer-school.html
Tropical Roots and Tubers: Production, Processing, Technology
Edith K. Sharma, Pragati Kaushal
Published by Wiley-Blackwell
Price £150

This volume sets out to provide a complete resource for research, industry and development professionals, whose work is touched upon by tropical root and tuber crops. It is thus both necessary and timely as attention is focused on decline in diversity in human agriculture and nutrition driven by the advance in human agriculture and crops. It is thus both necessary by tropical root and tuber whose work is touched upon over 100 countries worldwide consumed. 2.2 billion people in per head per day being also be major macronutrient variable, those that are in colour and/or of higher resolution (e.g. chapter 2) are better than others with poorer resolution and no colour (e.g. Fig. 1.2, 9.1.1). Non-photographic figures are all clear and instructive. There are also some very long tables, but, in general, layout and editing are of a high quality. At a cost of £150 or €180 from the publisher, the principal circulation of this volume is likely to be to libraries as opposed to individual consumers, although it would make a very valuable addition to book collections of those with a related academic interest.

Sterling Crew, FIFST, FCIEH, FRSPH, Vice President of the Institute of Food Science and Technology and Chair of the IFST Food Safety Group.
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The book contends that dining is far more a multisensory exercise than we might appreciate; food is not just taste and nutrition. Spence uses experimental psychology to give an insight into how the eating environment affects our food choices and preferences. This is a great book if you have ever wondered why we don’t like eating blue food or why 27% of the drinks bought on a plane are tomato juice? Why do we consume 35% more food when eating with one other person and 75% more when eating with three? Or what is the effect of serving food on plates that are small or red? Spence looks at how simple changes in the way we consume food could have a positive effect on what and how much we eat. It might have application for ways to cut calories and encourage healthier eating without compromising our enjoyment. It explains how food businesses could use this technology to transform our future eating experience and uncovers some of the tricks of the trade. The book is accessible, informative science at its best. For the professional, it has extensive set of notes and references providing access to current research in this field.

www.FStjournal.org/book-reviews/31-5/book-review/1

Dr Paul Wilkin, Head, Natural Capital & Plant Health, Science Directorate, RBG, Kew, Richmond, Surrey, TW9 3AE, UK.

The most impressive feature of the volume is the range of crops and disciplines covered. Many similar works cover just a single crop, but this book functions as a rich information resource on cassava, sweet potato (Ipomoea), yam (Dioscorea), elephant’s foot yam (Amorphophallus) and taro (Colocasia/Xanthosoma) in depth, with further information on species including Hausa or Chinese potato (Plectranthus), arrowroot (Maranta) and yam bean (Pachyrhizus). The early chapters of the book seek to introduce the main crop taxa via their biology, genetic and morphological diversity, chemistry and nutrition and modes of effective cultivation. While overall the quality of the text is relatively high, some of the key references are not cited here and statements are not always adequately supported by references. Biodiversity information is also variable in quality. There is inconsistency between crops, perhaps inevitable in a work of this breadth and involving 36 authors, in the coverage of existing research, for example in the genetic diversity chapter. Overall, however, a critical mass of research outputs has been assembled and reviewed effectively.

Subsequent chapters cover fermented foods and beverages, post-harvest storage (a major disincentive to tech industrial uses of tropical tubers."

The psychologist, Professor Charles Spence, Head of the Crossmodal Research Laboratory at Oxford University, looks at our multisensory experience of food. What is on our minds as we eat? He has studied how our brains process and integrate the information from our senses and how we perceive the world around us. He is a pioneer in the emerging field of Gastrophysics, a combination of gastronomy and physics, that dining is far more a multisensory exercise than we might appreciate; food is not just taste and nutrition. Spence uses experimental psychology to give an insight into how the eating environment affects our food choices and preferences. This is a great book if you have ever wondered why we don’t like eating blue food or why 27% of the drinks bought on a plane are tomato juice? Why do we consume 35% more food when eating with one other person and 75% more when eating with three? Or what is the effect of serving food on plates that are small or red? Spence looks at how simple changes in the way we consume food could have a positive effect on what and how much we eat. It might have application for ways to cut calories and encourage healthier eating without compromising our enjoyment. It explains how food businesses could use this technology to transform our future eating experience and uncovers some of the tricks of the trade. The book is accessible, informative science at its best. For the professional, it has extensive set of notes and references providing access to current research in this field.

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BENCHTOP AUTOCLAVES

Eco-friendly benchtop autoclaves

Astell has been leading the way in energy efficient small capacity sterilisers for over a decade.

As many organisations, including food science laboratories, place increasing importance on reducing their carbon footprint and utility costs, Astell Scientific provides one solution in its range of small capacity, front loading autoclaves. Astell’s Benchtop range is available in three chamber capacities: 33 litres, 43 litres and 63 litres, and as Classic and Autofill versions. Autofill was introduced in the early 2000’s and remains a popular feature as it offers both convenience and reduced water consumption.

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