SENSORY SCIENCE
GENETIC VARIATION IN TASTE

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3D PRINTING
REGIONAL AND TRADITIONAL FOODS
CENTRE FOR INNOVATION EXCELLENCE IN LIVESTOCK
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If it’s not in the genes...Qian Yang and Joanne Hort review the latest developments linking genetic variation with taste perception and food preference.

22 Staying in touch with food fraud: Catherine A. Johnson-Boyd discusses why the factual qualities of food and its packaging are so important in determining how consumers perceive different foods.

26 A salt on the senses...Simoneith Sudfied, Kiangkorn Ratanakajao, Neppaphi Chotusamunoon, Sriedo Sinattarit, Orn Ruangrak and Wilrose Pplayaw report recent research on consumer responses to different sodium reduction approaches.

30 From pixel to plate...Vaiva Kalnikaitė explores how 3D food printing can be used to create and enhance multisensory dining experiences.

34 The mark of authenticity...Carol Raditho discusses progress towards developing a sensory evaluation guideline as a part of the accreditation process for Processed Food Names (PFN) in the UK and the EU.

38 Centre for Innovation Excellence in Livestock...Casey Woodroffe explains the objectives of the Centre. How it has allocated initial grant funding and what the future looks like.

42 Seafood sustains a healthy diet...Charles Odilichukwu and Ivan Bartolo discuss the desirability of seafood consumption and its merits for healthy living.

45 Rethinking water use...Simon Emms explains the benefits of reducing reliance on mains water for food and beverage manufacturers.

48 Food inspection technology...Ruth Wright and Jack Severs investigate the rise of in-line food inspection technologies to reduce contamination risks and avoid product recalls and brand damage.

51 Food Authenticity Network...between Erik, Steve Ellison, Mark Wooff and Felicia Golden provide an update on the growth of this virtual network that brings together information on food authenticity testing to help all stakeholders better combat food fraud
PET project

Unilever has announced a partnership between its R&D Foods team, start-up company Ioniqa, a spin-off from the Eindhoven University of Technology in The Netherlands, and the largest global producer of PET (Polyethylene Terephthalate) resin, Indorama Ventures, to pioneer a new technology, which converts PET waste back into virgin grade material for use in food packaging.

Ioniqa has developed a proprietary technology that is able to convert any PET waste – including coloured packs – back into transparent virgin grade material. The new process breaks the PET down to molecular level, while separating out the colour and other contaminants. The molecules are converted back into PET at Indorama’s facility producing a material that is equal to virgin grade quality.

The technology has successfully passed its pilot stage and is now moving towards testing at an industrial scale. If successful at industrial scale, in future it will be possible to convert all PET back into high quality, food grade packaging. The three partnering companies believe that this fully circular solution could lead to an industry transformation, since the new technology can be repeated indefinitely. PET is widely used to produce plastic packaging, yet worldwide only around 20% of this material makes its way to recycling plants with the rest either incinerated, disposed of in landfills or leaking into the natural environment.

Unnecessary, single-use plastic packaging should become a thing of the past as businesses sign up to a world-first pact, which aims to transform the plastic packaging system in the UK and keep plastic in the economy and out of the ocean.

The UK Plastics Pact was launched by the Ellen MacArthur Foundation in April 2018 and will be led by WRAP (Waste Resources Action Programme). It is a unique collaboration which brings together businesses from across the entire plastics value chain with UK Government and NGOs to tackle the scourge of plastic waste. Forty-two businesses, including major food and drink manufacturers and retailers right through to plastic reproducers and packaging suppliers, have made a commitment to the Pact. These Pact members are responsible for over 80% of the plastic packaging produced sold through UK supermarkets. In addition, 13 other organisations have also shown their commitment to the Pact.

The UK Plastics Pact is expected to be the first of its kind in the world. The aim is to replicate it in other countries to form a powerful global movement for change as part of the Ellen MacArthur Foundation’s New Plastics Economy initiative. Chile is expected to establish a pact later this year.

The Pact aims to create a circular economy for plastics that tackles the causes of plastics waste and pollution, not just the symptoms. It focuses on innovation, better packaging design and end-of-use systems that will not only generate long-term benefits for the environment, but also represent an economic opportunity. In the UK, the Pact should stimulate innovative new business models to reduce the total amount of plastic packaging. It will also help build a stronger recycling system, where we take more responsibility for our own waste and ensure plastic packaging can be effectively recycled and made into new products and packaging.

The immediate focus will be on identifying the priority projects that will deliver greatest impacts in the short and long term, such as overcoming barriers to increasing the amount of recycled content used in new packaging, developing reusable packaging and working with partners to overcome the issue of un-recyclable black plastic.

WRAP will be launching a campaign in summer to engage citizens and help them to take action.

Unpublished articles can assess dietary-related diseases such as obesity.

Characteristics optimised to appeal to children can increase the occurrence of noncommunicable diseases, which are associated with high consumption of calories, sugars and salt. Foods with sensory packaging have potential to be used to develop foods that are more nutritious and can help to affect how foods are perceived and influence consumer mood and choices. This area of sensory science, although currently mostly the preserve of celebrity chefs and restaurateurs, has exciting potential on a wider scale for the future.

Sensory science can be used as a tool to measure consumer response during food product development. For example, it can measure consumer response to changes in concentration of salt (p26) and sugars in foods. It can also be used to measure the authenticity of regional and traditional foods (p33).

Editorial

Melanie Brown

This issue of FS&T has a focus on sensory science and food perception. As consumers become more aware of dietary links to health and wellbeing, they demand foods that meet their nutritional, lifestyle and health needs. Manufacturers not only need to respond to government initiatives to improve the health of the population, but also to produce foods that are acceptable and palatable to consumers. The understanding of sensory science and its use to determine consumer acceptance and preferences for different foods is becoming increasingly important.

Current research is showing that genetic variation between individuals can account, at least in part, for variation in taste sensitivity, food preference and dietary habits (p18). This is a relatively new research area, which needs further exploration to improve understanding of the links. Along with taste, small and sight, touch in the form of food texture or food packaging has also been shown to affect food perception (pp27). We are likely to see taste tactics being used increasingly to communicate specific food messages. Food presentation, including for example 3D printing of foods (p30), can also affect how foods are perceived and influence consumer mood and choices. This area of sensory science, although currently mostly the preserve of celebrity chefs and restaurateurs, has exciting potential on a wider scale for the future.

Sensory science can be used as a tool to measure consumer response during food product development. For example, it can measure consumer response to changes in concentration of salt (p26) and sugars in foods. It can also be used to measure the authenticity of regional and traditional foods (p33).

Sensory attributes of foods and their packaging have potential to be used to develop foods that are more nutritious and can help to reduce the occurrence of noncommunicable diseases, such as type 2 diabetes and heart disease. Frequently, these diseases are associated with high consumption of calories, sugars and salt. Foods with sensory characteristics optimised to appeal to children could encourage more nutritious and healthy diets and reduce the incidence of childhood obesity.
Cutting calories

Public Health England (PHE) was commissioned by government in August 2017 to consider the evidence around children’s calorie consumption and to set the ambition, scope and timeline for extending the reformulation programme, set up in 2016, to cover the foods that contribute significantly to children’s calorie intakes. In March 2018, PHE published a report of its findings entitled ‘Calorie reduction: The scope and ambition for action’.

The report concludes that there is a clear case for taking further action to reduce people’s daily consumption of calories. At a population level, children and adults are consuming excess calories on a daily basis. The report demonstrates that the benefits of reducing this excess consumption, both in terms of preventing premature deaths and saving NHS healthcare costs and social care costs, are substantial. A 20% reduction in calories from everyday foods that contribute to intakes, if achieved over 5 years, would prevent 35,370 premature deaths, save the NHS £4.5bn healthcare costs and save social care costs of around £4.4bn, over a 25 year period. According to the report, the salt reformulation programme has significantly reduced levels of salt in foods and consumption of salt by individuals; businesses have also begun to take action on sugar reduction. The evidence suggests that a similarly structured programme delivering an ambitious reduction in calories would also bring benefit to the population.

The proposed calorie reduction programme challenges the food industry to achieve a 20% reduction in calories by 2024 in product categories that contribute significantly to children’s calorie intakes (up to the age of 18 years) and where there is scope for substantial reformulation and/or portion size reduction. This requires work to be undertaken by retailers and manufacturers, restaurants, pubs, cafes, takeaway and delivery services and others in the eating out of home sector. The products covered by the programme include ready meals, pizzas, meat products, savoury snack products, sauces and dressings, prepared sandwiches, composite salads and other ‘on the go’ foods including meal deals. It does not cover foods

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PHE will work behind the scenes with the food industry to slowly improve the calorie and wider nutrient content of everyday foods without families having to proactively make fundamental changes. It will undertake work to further define the food categories to be included in the programme with baseline analysis for each of these to assist businesses.

This will inform proposed category guidelines, which will be subject to comprehensive engagement and consultation with industry and other stakeholders later in 2020. It is expected that the industry guidelines will be published mid 2021 alongside baseline levels of calories in the food categories included in the programme for the year ending August 2017.

Businesses are encouraged to start work now to reduce the calorie content of everyday foods included in the calorie reduction programme. PHE will closely monitor or progress by businesses and produce detailed reports annually from 2020. It will advise government if sufficient progress is not being made.

The calorie reduction programme focuses on large businesses that are providing the greatest volume of foods and consequently calories into the food chain. It incorporates foods providing an additional 19% of the calories consumed by children into the reduction reformulation programme. Together with the sugar reduction programme (25% of calories) and drinks (5% of calories, which come from drinks that are included in the soft drinks industry key and PHE’s separate programme), this will broadly account for 50% of children’s overall calorie intakes.

Although the programme focuses on foods consumed by children up to the age of 18 years, families eat the same foods and therefore it should support all family members in reducing their calorie consumption, particularly with continued support through the Change4Life and OneYou campaigns. It should also help to address health inequalities, as rates of obesity in children tend to be highest in the most deprived groups.

The reduction and reformulation programme, and the calorie reduction work specifically, is a key intervention that PHE believes will contribute to reducing the incidence of childhood obesity.

New assay for mycobacteria in milk

A new, highly sensitive test has found that 10% of milk samples contain low levels of mycobacteria pathogens according to research due to be published in Food Microbiology.

The phage-based assay, ActiphageTM, developed by PRD Biotech, can distinguish between viable and non-viable organisms. It found viable Mycobacterium avium subspecies paratuberculosis (MAP) in 10.3% of the 286 samples of retail purchased pasteurised milk tested.²

Two-thirds of the MAP-positive samples (6.8%) contained just 1-2 detectable MAP cells per 50ml, with a further 1.1% (6.8%) contained just 1-2 detectable MAP cells per 50ml.

Previous milk studies using culture or PCR-based detection methods were unlikely to detect less than 100 MAP cells per 50ml, explaining why this new more sensitive method found more MAP-positive samples. MAP causes Johne’s disease, a chronic wasting disease of cattle and other ruminants, which not only affects animal health but has a significant economic impact on the dairy industry hence the need for regular milk testing to detect and monitor herd-level infection.

MAP has also been implicated in the development of Crohn’s disease, with the mycobacteria found in the bowel tissue of a proportion of patients with the condition. However, no causal relationship between MAP and the inflammatory bowel condition has been established.

Although many studies have shown that MAP can be detected in pasteurised milk, this new research reveals that the mycobacteria were not introduced through poor hygiene standards and faecal contamination but were shed directly into the milk samples through somatic or ‘body’ cells within the cow’s udder.

The location of MAP internalised within somatic cells may explain why low-levels of the mycobacteria were not introduced through poor hygiene standards and faecal contamination but were shed directly into the milk samples through somatic or ‘body’ cells within the cow’s udder. The location of MAP internalised within somatic cells may explain why low-levels of the mycobacteria are protected against heat inactivation during pasteurisation. There is no regulatory MAP count limit for milk or other dairy products, however the new ActiphageTM assay, which delivers results in hours, will enable producers and processors to more efficiently and effectively assess milk as part of the production line. The phage-based assay has also been used to detect viable MAP in raw milk, powdered infant formula, cheese and in the blood of infected animals.
Acrylamide Analysis

Recent regulation updates require food operators to put in place practical steps to ensure that acrylamide levels are as low as reasonably achievable in their products. Eurofins Food Testing UK & Ireland offers UKAS accredited analysis for the determination of acrylamide in a range of food products including coffee, and our method has been validated according to the requirements set by Regulation (EC) No 882/2004.

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David Gregory
President, IFST

Firstly, thank you to those of you who attended the Volunteers Group Meeting and AGM, which this year was held in London. We were delighted to have such a well-attended afternoon and evening and really appreciate the support volunteers give to IFST in so many ways.

We also held our Spring Conference (SC18) at the University of Birmingham. Once again, we were delighted with the attendance and are very grateful to the speakers who ably covered a very wide range of emerging science and technology topics that will impact on all of us in the next few years.

At the dinner the night before the conference, the futurologist Chris Barnatt explained to us how the worlds of food, medicine and digital are merging together, which was completely reflected by the speakers the following day, whose talks ranged from human and pathogen genetics to the use of Google glasses in supplier audits. Feedback on this conference has been excellent and reflects the very high standard we set last year. We are already starting to work on the next conference.

Looking forward, you will see the new website for IFST going live in the next couple of months. This has been a major exercise and investment for IFST. We want to make life easier for our members so the website is aimed at making more information accessible to us all. We look forward to getting feedback from you all on this important initiative.

We are pleased to announce that Michael Bell has been elected as the new Vice President of IFST. He was invested during IFST’s Annual General Meeting on 13 March 2018.

Of his appointment, Michael said: ‘I am looking forward to supporting the Institute of Food Science & Technology and its members during the most exciting time for UK Agri-Food since IFST was created. We have a lot of building to do, but together, we have a superb legacy to build on.’

Michael has over 34 years’ experience in the food industry and has been the Executive Director of Northern Ireland Food and Drink Association (NIFDA) for over 22 years. He previously worked in Northern Ireland and Malta for 12 years working closely with major retailers and was a member of the Board of Donegal Bakery.

Michael has an honours Degree in Food Science and is a Fellow of IFST and a Chartered (Food) Scientist (CSci). He is a Fellow of the Institute of Directors (FInstD) and is a Chartered Director (C Dir). He also has a Leaders in Industry Programme Food and Drink Manufacturing sector award from Queen’s University, Belfast. Michael is Chairman of the Northern Ireland Agricultural Research and Development Council (AgriRes) and a member of Safefood Expert Advisory Committee. In addition, Michael is a member of the Board of Ormeau Bakery.

Northern Ireland Food and Drink Advisory panel for the Food Standards Agency Northern Ireland and a board member of Agri-Quest – the Food Innovation Competence Centre. In his spare time, he enjoys sailing, hill walking as well as good food and drink.

Michael Mosley announced for IFST Lecture

The IFST Lecture is always one of the highlights of our calendar. This year we are delighted that our guest speaker will be Dr Michael Mosley, well-known British television journalist, producer and presenter, who will talk about the role of the media in presenting evidence-based science to the general public.

Michael studied PPE at Oxford and then became an investment banker before realising that this really wasn’t the industry for him...so he retrained as a doctor.

After studying medicine at the Royal Free Hospital in London and qualifying as a doctor...he realised that this wasn’t really the industry for him either! Michael joined the BBC as a trainee assistant producer and over the ensuing 25 years has made numerous science and history documentaries for the BBC, first behind the camera and more recently as a presenter. He’s won numerous awards, including being named Medical Journalist of the Year by the British Medical Association in 1995.

He writes for the Mail on Sunday, The Times and The Independent. He is also a regular columnist for Focus magazine and Eureka.

The IFST Lecture 2018 will take place on 27 June in London. It will also be live streamed to various satellite receptions around the UK. Please note that it is an invitation only event.
The Digital Twin for the food consumer: on food industry software solutions, presented bacterial responses to environmental to support management of foodborne security rankings, ‘sequencing alliance for Food Safety) discussed: global food in food risk is required from the food sector. resistance (AMR), and that more surveillance for food safety and reducing antimicrobial and explained how a better understanding of conditions supporting microbial growth and survival in the food chain is crucial for food safety and reducing antimicrobial resistance (AMR), and that more surveillance is required from the food sector. Trimming the US with a paradigm shift in food risk by Daniel Hurley (UCD, Centre for Food Safety) discussed: global food security rankings, ‘sequencing alliance for aging environments’ (SAFE), improving food safety through advances in whole genome sequencing based surveillance. GenomeTrakr support management of foodborne outbreaks and how transposon-directed on-pack technology (Traxx) facilitates bacterial responses to environmental conditions.

John Graydon (Siemens), a specialist in food industry software solutions, presented on The Digital Twin for the food consumer: ensuring data integrity showing that creating virtual copies and simulation can optimise products and processes. He highlighted the importance of food chain integrated data systems (intra-company and supplier collaboration) from product design stage, concluding that the right technology, observations and data become the right information.

The topics progressed to Tracking and Tracing Technologies, with James Flynn (Primority) covering the use of technology to rapidly transform food safety and supply chain transparency, e.g. traceability and authenticity, in Everything you need to know about Blockchain (but were too afraid to ask). James explained how this database technology will potentially create disruptive, transformative innovation, and when applied to food supply chains will provide competitive advantage, hence the need for industry to be informed and ready. Regarding security, blockchains, which are a decentralised way to reach consensus, can be permissioned to maintain commercial sensitivity with costs relating to access of database ‘nodes’. James Stafford (Avery Dennison) stressed how radio frequency identification (RFID) can improve business profitability and customer service but appreciated the need for businesses to build a business case to justify investment. The topic was entitled RFID Tracking Technology, short term gains and long-term benefits and referenced the application to shipping trays and pallets for individual items (meat and ready meals), including best before dates. Other consumer benefits of UHF RFID labelling are in e-commerce and for faster self-checkout at retailers.

This was expanded with Embedded RFID on pack technology by Professor Rob Stevens (Nottingham Trent University), who develops electronic printing into e.g. in-mould label (RFID-IML) programmed at the filling stage to support an immutable global food blockchain. He explained how cost effective smart hybrid labels will transform supply chains to deliver safer food with consumer benefits and features, such as labels that light up. The challenges of introducing new and disruptive features to conventional food packing lines, whilst maintaining productivity and cost-effectiveness, are demanding.

The afternoon’s focus was Future Assurance and Vincent Duxmestel (Lloyd’s Register) introduced The future of food audits. Less people are living in absolute poverty but there is increased consumer demand e.g. quality, security, sustainability, protection and food safety (classified as ‘data’ and ‘life sciences’).

The challenges for responsible and resilient supply chains are population growth, fraud, climate change, DNA sequencing and new technologies. Assurance mechanisms are changing with the need for more remote audits, due to insufficient resources and the requirement for improved communication as systems are outdated.

Brian Courchesne (Schneider Electric) introduced Why cybersecurity matters in the food and beverage sector now vs cyber attacks are growing exponentially. Threats can be posed by hackers, criminals and insiders, as well as from espionage, terrorism and warfare.

A comprehensive defence approach requires identification and recovery stages as well as protecting, detecting and responding, focusing on people, process and technology to protect brands, reputation and assets.

The world through the auditor’s eyes – alternative global auditing solutions by Rob Churchill (NSF). NSF discussed remote auditing with the use of augmented reality (AR) glasses and the benefits of artificial intelligence (AI) to eliminate operator error. A system was discussed to predict changing risk, using big data, to enable prioritisation for intervention and continuous improvement. Culture remains a significant challenge and the prediction is that most technologies that will be dominant in 30 years time have yet to be invented. The chair concluded the day by providing a useful round up of these topics.

Presentations are available for members on the IFST website.
We are pleased to announce that Paul Rama and Andrew Dockrell have been nominated as IFST Ambassadors 2018.

Earlier this year, we set out to build a network of Ambassadors to help us in our mission to promote the ‘voice of the food profession’ by sharing knowledge and redressing the imbalance of stakeholders, promoting professional development and encouraging new entrants to the sector as an exciting worthwhile and aspirational career path.

We were overwhelmed with the interest in this 16-month role having opened it up to young professionals and overseas members as well as students. The judges were equally impressed with the calibre of candidates.

To read an interview with Qudsiyah and Andrew Dockrell, please go to https://www.ifst.org/news/introducing-our-new-ifst-ambassadors

IFST Ambassadors 2018

Qudsiyah Eeke and Andrew Dockrell receiving their Ambassador awards from David Gregory

Interview with Sterling Crew, outgoing IFST Vice President

Sterling, how have you found your time as IFST Vice President? It has been fantastic and a real honour. It is such a privilege to have been given the opportunity to connect with the membership. I have been very fortunate to have served with three great Presidents: Margaret Patterson, Maureen Edmondson and our current President Daniel Gregory. I have learnt a lot from them and from our CEO Jon Poole and his team. It’s been a huge privilege and fun as well.

What was important to you when you first took up the post? Trying to play my part in increasing membership value. It is key to our future growth. We should not forget we are first and foremost a membership organisation: It has been my mantra.

What is the main challenge ahead for the profession? Maintaining the trust of the public. Food consumed in the UK is amongst the safest, most authentic and nutritious in the world. Yet, many in the general public remain unconvinced of the benefits that food science can deliver. This has been fuelled by food scares and misinformation. Sensational media coverage is bringing about a climate of apprehension, where there should be none. We must endeavor to present evidence-based information to help members of the public make informed decisions.

What are your views as a trustee? It has been reassuring to see IFST further strengthen its financial position and governance structure. It helps secure its future. We have seen recently a number of other charities have not fared so well. We should not take our future for granted. The organisation must continue to innovate and improve. The stewardship role of a trustee is critical.

Any recent changes you would highlight? The investment in two new positions of Policy and Scientific Development Director and Scientific Affairs Manager. It means we can communicate and connect more effectively with our stakeholders, NGOs, the public and better serve our membership. It is a step change for us. It is important that we can inform and influence our key stakeholders, especially with Brexit on the horizon and potential changes in the way food is to be regulated.

What has been your most enjoyed? Interacting with our students. I have been impressed with their professionalism and their enthusiasm, which is infectious. The future of the profession is in their hands.

Please outline the future of the profession? What challenges are there for IFST in your area of work? I have spent 35 years working in the food supply chain. Food and drinks strategy is the largest manufacturing sector in the country and employs over 450,000 people. It feeds our nation. We are facing a huge technical skills shortage which we cannot ignore. We need more trained food technicians and scientists to fill the gap. Our profession is still relatively unknown. We need to raise its profile and shout out about the rewarding careers available to encourage more people to join us.

Are there any future IFST developments you are looking forward to? We have taken the first steps towards applying for the status of charity. We don’t know how long the journey will take or what its final outcome might be, but I believe success would be great for IFST and its individual members, a real coming of age for the profession.

There are also some exciting plans to make the membership application process a lot easier and to further improve communication and enhance the whole membership experience. Keep an eye out for the upcoming refresh of the Food Safety Register. It helps give employers the confidence and assurance they are looking for and for our members it forms a key part of their professional development.

What would you do if you had a magic wand? I would definitely use it to sort out our country’s obesity epidemic. It is reaching horrific levels with no signs of it being reversed in sight.

Any final thoughts? We should ask ourselves not what IFST can do for us but what we can do for IFST. It’s membership engagement that drives our organisation. We should all play our part where we can.

I would urge members to become actively involved by joining their branches, special interest groups or the various Institute committees. There are also chances to meet fellow food professionals at the numerous presentations and conferences. You can help shape IFST’s future and meet some great people.

Sterling Crew IFST has just completed two terms as IFST Vice President. We asked him about some of his ongoing thoughts.

Tipochemical composition and sensory characteristics of Cabernet Sauvignon wines from different harvest dates. The effects of three water status levels and two harvest dates (53 and 64 days after véraison (DAV)) on phenolic and sensory composition of Cabernet Sauvignon wines was investigated.

The later harvest date led to wines with a higher alcohol content. Total phenols varied from 14.86 to 16.81 g/L with higher values at 64 DAV. No differences were observed between irrigation treatments. For total tannins and anthocyanins, no differences were found between harvest dates. Separation of proanthocyanidins by Sep-Pak Plus IC5 cartridges showed only differences in concentration but not in the proportion of proanthocyanidin fractions.

The wines from the most water restricted treatment had a better colour and the same aroma of red fruits, persistence, astringency, fullness and bitterness as the wines from the treatment with highest irrigation. Under the DAV conditions, it was possible to obtain wines with a similar chemical and sensory composition earlier and using less irrigation water.

Delgado Cuamor et al., 2018, doi: 10.1111/ijfs.13757

Influence of crystal promoters on sensory characteristics of chocolate. Three additives that acted as crystal promoters (CP) at varying concentrations, were studied to determine their effect on sensory characteristics of heat-resistant compound chocolates using trained descriptive panellists.

The non-heat-resistant compound chocolate with no CP added served as a control. CP1 was composed of mono– and diglycerides and polyglycerol esters from high oleic sunflower oil. CP2 consisted of triglycerides from fully hydrogenated canola oil. The sample with 0.25% CP1 was most comparable to the control with higher cocoa, dark brown, bitter aromatic and sweet intensities and higher ‘seaweedy flavour’ that the control.

The study concluded that CPs containing no MA, low MA (15 g/kg) or high MA (30 g/kg) for 95 days before slaughter. Steaks from animals fed either the MA diets had a marginally higher ‘seaweedy’ flavour that was positively correlated to muscle C22:6n-3 concentration. Steaks from animals fed high MA were rated as being higher in tenderness and had a lower shear force than those from control fed animals.

The study concluded that feeding microalgae at high levels can beneficially improve the health attributes of beef with minimal effects on sensory quality.


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Phenolic composition and sensory characteristics of Cabernet Sauvignon wines from different harvest dates. The effects of three water status levels and two harvest dates (53 and 64 days after véraison (DAV)) on phenolic and sensory composition of Cabernet Sauvignon wines was investigated.

The later harvest date led to wines with a higher alcohol content. Total phenols varied from 14.86 to 16.81 g/L with higher values at 64 DAV. No differences were observed between irrigation treatments. For total tannins and anthocyanins, no differences were found between harvest dates. Separation of proanthocyanidins by Sep-Pak Plus IC5 cartridges showed only differences in concentration but not in the proportion of proanthocyanidin fractions.

The wines from the most water restricted treatment had a better colour and the same aroma of red fruits, persistence, astringency, fullness and bitterness as the wines from the treatment with highest irrigation. Under the DAV conditions, it was possible to obtain wines with a similar chemical and sensory composition earlier and using less irrigation water.

Delgado Cuamor et al., 2018, doi: 10.1111/ijfs.13757

Influence of crystal promoters on sensory characteristics of chocolate. Three additives that acted as crystal promoters (CP) at varying concentrations, were studied to determine their effect on sensory characteristics of heat-resistant compound chocolates using trained descriptive panellists.

The non-heat-resistant compound chocolate with no CP added served as a control. CP1 was composed of mono– and diglycerides and polyglycerol esters from high oleic sunflower oil. CP2 consisted of triglycerides from fully hydrogenated canola oil. The sample with 0.25% CP1 was most comparable to the control with higher cocoa, dark brown, bitter aromatic and sweet intensities and higher ‘seaweedy flavour’ that the control.

The study concluded that CPs containing no MA, low MA (15 g/kg) or high MA (30 g/kg) for 95 days before slaughter. Steaks from animals fed either the MA diets had a marginally higher ‘seaweedy’ flavour that was positively correlated to muscle C22:6n-3 concentration. Steaks from animals fed high MA were rated as being higher in tenderness and had a lower shear force than those from control fed animals.

The study concluded that feeding microalgae at high levels can beneficially improve the health attributes of beef with minimal effects on sensory quality.

Food supply and safety negotiations before Brexit

Tony Lewis, Head of Policy at the Chartered Institute of Environmental Health, raises concerns about the lack of planning by the Government for the UK’s food supply post Brexit.

The responsibilities of such professionals are to the common good, including the public’s safety and health. It is for the Government to negotiate and agree systems and procedures to address these critical issues. The risk is that, if these issues are not adequately addressed, on Brexit day and on the day following it, food will be left rotting on quaysides or in holding warehouses.

Article available online at fjsjournal.org/features/agri-food-supply-safety-post-brexit

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Food supply and safety negotiations before Brexit

Food supply and safety negotiations before Brexit negotiations are likely to result from this, although the Research Councils and Innovate UK have worked together in the past successfully on a number of initiatives, such as the Sustainable Agri-Food Innovation Platform and the AgriTech Catalyst.

The Government has stated its ambition to increase UK investment in R&D to 2.45% GDP by 2027 with an eventual target of 3%. To support this vision of growth in prosperity, driven at least in part by industrial productivity growth, the Industrial Strategy: Building A Britain Fit For The Future was published in November 2017. This outlines key policies supporting the future of food and drink innovation around infrastructure, place and people. An Industrial Strategy Challenge Fund (ISCF) to capture the value of innovation generated by the UK has been created and significant new funding (£550m) for the agriculture sector was announced in Spring 2018.

The third ‘wave’ of funding will be awarded as a result of proposals to an open competition in which the food manufacturing and retail sectors have supported applications in the Food and Growth Challenge area around resource efficiency in manufacturing and alternatives to single-use plastics in production. If successful, the business should be able to take the challenge areas will be prepared for Autumn 2018 with funding from April 2019. The Industrial Strategy is also providing opportunities for partnerships between the Government and industry sectors on specific issues, with innovation, skills and export frequent areas for inclusion. The food and drink manufacturing sector led by the Food and Drink Federation has a proposal under consideration with innovation as a major theme.

Within the business-as-usual mode, food and drink businesses are able to apply to a number of funding streams from Innovate UK to develop new ideas and services, including competitions for solo and collaborative R&D, Knowledge Transfer Partnerships are a particularly favoured form of innovation support presently, building links between businesses and the research base.

Businesses based in the devolved administrations may also be able to access specific support and funding for innovation through local schemes, e.g. Scottish Enterprise’s package of support measures. However, post-Brexit, schemes currently using EU funding pots may not receive such generous or broadly-based support as is available today.

Businesses wishing to support academic research will continue to have the option to support the Research Councils, such as BBSRC’s Collaborative Training Partnerships and programmes of collaborative research, such as the EPSRC’s Partnerships for a Prosperous Nation scheme.

Future government-based support for businesses and academics interested in working with industry appears likely to follow the route of challenge-led programmes and bilateral agreements with overseas partners, e.g. the UK-India and UK-Colombia research programmes, the Global Challenge Research Fund and the Resilience of the UK Food System in a Global Context programme. Future EU funding, such as Horizon 2020 projects, UK partners are being encouraged to continue to apply to and take part in proposals with a guarantee in place for the lifetime of any projects funded. Anecdotally, we are still finding that businesses are being approached for inclusion in applications although future UK involvement in the large range of EU-based funding instruments is not yet clearly defined. Possible options for the next EU Framework Programme 9 (likely to run from 2022) include participation as an ‘Associated Country’, as is the case for Switzerland, Norway and Israel, but there has not yet been a firm commitment to this despite the UK’s continuing success in attracting EU-based grant funds.

For start-up businesses or innovation-driven businesses seeking equity funding to grow, the indicators are that investors are still available although future activity in these investor-led areas tends to reflect the overall economic climate and sentiment of the markets, so it may change with the reality of Brexit or may stay exactly the same!

The KTN works with businesses to connect them with the research expertise they need to meet their innovation needs. Feel free to contact the team to find out more about how we can help.

Article available online at fjsjournal.org/features/agri-food-supply-safety-post-brexit

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Funding innovation post Brexit

Funding innovation in the food and drink sector post Brexit for businesses is likely to be ‘similar but different’ to the current funding landscape. In terms of UK Government support for the sector, a recent key change, although not Brexit related, is the incorporation of the previously Independent UK into an umbrella organisation (both sides of UK Research and Innovation), together with the funding bodies for academic research (Research Councils), such as BBSRC and EPSRC. It is early days to assess how much change in focus and/or in mechanisms of support CIEH and FRC are clear that such talk is, in fact, nonsense. Technological solutions may or may not be possible in the future, but they do not exist at present. Furthermore, technological solutions cannot replace the need for food inspection at UK ports of entry by qualified and competent food professionals.

Proper food inspection requires someone to look inside lorries and make judgements about critical food safety and standards. At present the Government seems to be taking a relaxed approach to the issue of cross-border trade, but CIEH and FRC believe that port health officials, customs officers and other trade and health-related professionals should not be expected to resolve political difficulties, nor should responsibility for resolving practicalities be placed at their door.

The responsibilities of such professionals are to the common good, including the public’s safety and health. It is for the Government to negotiate and agree systems and procedures to address these critical issues. The risk is that, if these issues are not adequately addressed, on Brexit day and on the day following it, food will be left rotting on quaysides or in holding warehouses.

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It’s all in the genes

Qian Yang of the University of Nottingham and Joanne Hort of Massey University review the latest developments linking genetic variation with taste perception and food preference.

Introduction
Taste stimuli are detected by taste receptors located in taste buds throughout the oral cavity, including the tongue, palate and throat. If you stick your tongue out and look at it in a mirror, you can see small pink bumps on the tip of your tongue which are the fungiform papillae – one type of papillae that house taste buds.

Humans are able to recognise five basic tastes: sweet, bitter, sour, salty, and umami (savoury). Recently, fatty taste, named oleogustus, has been identified as a candidate for a sixth basic taste.

From an evolutionary perspective, each taste is believed to function as a detector for our nutritional or physiological needs or of potential hazards.

Sweetness signals calorie-rich food, which is a great source of energy. Umami signals the presence of protein-rich food, which is essential for growth and repair of body cells. Salty signals the presence of sodium or other salts, which are essential for maintaining the body’s water balance and blood circulation. Bitter taste is innately aversive, and thought to be a warning for potentially poisonous food, as most toxic substances taste bitter to humans. Sour taste is believed to signal spoilage of foods. ‘Fat taste’ may have evolved to signal energy-rich foods as a candidate for a sixth basic taste.

Many studies have published evidence that taste sensitivity varies greatly among individuals and is one of the potential factors affecting food preference and choice. Our body hormones and proteins are under genetic control, thus variations in our genes are believed to affect the efficiency of our taste receptors. Consequently, understanding the link between genes, taste sensitivity and food choice could provide insights into consumer segmentation and help to develop effective strategies to provide customised foods/diets and promote healthy eating.

In recent years, genome-wide association studies have become a popular tool to detect genetic variants that contribute to taste perception/preference and some diseases. Single nucleotide polymorphisms (SNPs) are representative of genetic variation among people, where the type of nucleotide (A-adenine, T-thymine, G-guanine, or C-cytosine) can differ between individuals. This article summarises current understanding concerning the link between individual variation in taste perception and genetics.

Sweet perception
Humans are innately predisposed to enjoy sweetness. However, excessive sugar consumption has been linked to a range of public health issues, such as diabetes and obesity. Recently, due to the alarming increase in these health problems in populations across the world, the World Health Organisation (WHO) urged global action to curtail consumption of sugary drinks to reduce obesity, type 2 diabetes and tooth decay. Thus, understanding individuals’ genetic make-up, taste perception and their drive for sweetness could potentially help with interventions to tackle these health problems.

Individual preference to sweetness levels in food varies. Researchers have grouped individuals as sweet likes (SL), who prefer increasing sweetness levels, and sweet dislikers (SD), who prefer lower levels of sweetness and show increasing dislike as sweetness increases. This taste phenotype is referred to as an individual’s Sweet Liking Status (SLS) and is a great source of energy. In a recent study conducted at the Sensory Science Centre at the University of Nottingham, overall liking for sugar solutions, orange juice and yoghurts varying in sweetness levels was collected from 58 participants. The study found that 21 preferred the high sugar solution (36g/l sugar in water), whereas 37 preferred the low medium sugar solutions (3 to 12g/l sugar in water). Similar trends were observed for both orange juice and yoghurt, where SL did not have a clear preference for both products, but SD preferred the low sweet orange juice and yoghurt over high sweet samples (see Figure 1). T1R2 and T1R3 are G Protein-Coupled Receptors that function in combination to detect the sweetness of a wide variety of natural sugars and artificial sweeteners in the oral cavity. A genome-association study has examined variants at rs35874116 of TAS1R2 in 1037 diabetes-free individuals and 100 individuals with diabetes, as well as their dietary intakes. A significant association between rs35874116 and sugar consumption in BMI >25 individuals was observed, where the ‘Val’ genotype consumed less sugar than the ‘Ile’ genotype. Variants at rs307355 and rs35744813 of the TAS1R3 were also examined in a 144 mixed ethnicity cohort; CC genotype for both SNPs was significantly associated with increased sucrose sensitivity. A recent study has examined the rs838133 of ‘Fibroblast growth factor 21’ (FGF21), a sugar-induced hormone that contributes to the metabolic regulation of...
The researchers reported that variants at rs838333 were associated with total intake of all types of sweet-tasting foods, with A alleles self-reporting higher intake.

### Bitter taste perception

The ability to taste bitter compounds containing a thiazole (N–C–S) moiety, such as PTC and 6-n-propylthiouracil (PROP), varies greatly among individuals. This phenotype, called PROP Taster Status (PTS), has been studied widely since its discovery in 1932. Based on an individual’s ability to taste PTC/PROP, individuals can be grouped as ‘super-tasters’ if they are supersensitive to PTC/PROP and non-tasters if they are insensitive. Around 25% of caucasians are extremely insensitive to this compound and another 25% cannot taste it; this leaves about 50% of the population that perceive PTC/PROP at a medium intensity. Super-tasters also have heightened taste sensitivity to other oral sensations, such as sweet, salty, fat and temperature sensations. PROP tasting has been associated with greater bitterness sensitivity to brassica vegetables and lower acceptance of cruciferous and some raw ingredients[28], 29]. Recent evidence has shown that gustin (rs2274333), which is a tropic factor for the growth and development of taste buds, may also be associated with PTS[30]. This was hypothesised to be the reason behind super-tasters’ increased number of fungiform papillae and their super-sensitivity. However, a later study failed to replicate this finding[31].

### Salty taste receptors

There are at least two saltpan transduction pathways that have been proposed. The Aminoamide-sensitive transduction pathway is cation selective (Na+ and Li+) and is proposed to be mediated by ENaC, a member of the degenerin/Epithelial sodium channel family of ion channels. An Aminoamide-insensitive pathway is cation nonselective and can be activated by both sodium and nonosodium salts[32]. Potential Vascular-1 (TRPV1) is a transducer of painful thermal stimuli and it is also activated by capsaicin, which has been proposed to function as an aminoamide-insensitive salt taste receptor in rodents[33]. A study has looked into the association between genetic variants in ENaC (SCNN1A, SCNN1B, SCNN1G and SCNN1D) and TRPV1 and salt sensitivity in 35 Canadians. Evidence that the SCNN1B gene was associated with salt sensitivity; those with homozygous A alleles for rs393945 and T alleles for rs795368 perceived salt solution less intensely than T or C alleles respectively. For the TRPV1 gene, T allele carriers of rs680588 were significantly more sensitive to other than C allele carriers[34].

### Sour taste receptors

Many ion channels have been proposed to mediate sour taste. It has been suggested that a broad range of receptors and mechanisms might be responsible for sour taste perception[35]. P2X2 and P2X3 are popular candidates for sour taste receptors that have been identified through gene expression studies; however, none has yet been definitely proven[36]. Little is known about individual variation in sour taste perception and how such variation may be linked to genetic variation. The sour taste receptor is only just beginning to be explored and not a lot more research is needed to understand its complexity.

### Fat perception

The perception of fat involves many sensory modalities, such as somatosensory, olfactory and potentially a motor system[37]. Recent evidence has suggested that fat taste could be another basic taste[38, 39]. Studies have shown that fatty acids are detectable by human tongue as ‘salty’ and the transduction mechanism of fat taste is not fully understood, CD36, a fatty acid translocon that is involved in fat detection and preference in animal studies, was suggested as an orosensory receptor for long chain fatty acids[40]. A number of genome-wide association studies have investigated the relationship between CD36 SNPs and fat sensitivity. The most significant SNP is rs716167 CD36. AA genotype of rs716167 was found to be associated with perceived creaminess that was independent of fat concentration in salad dressings when tested in 317 African American adults[41]. But in another study tested in 64 Italian adults, AA genotype was associated with lower sensitivity to oleic acid, which conflicts with Keller’s findings. A significant SNP (rs716167) at the first allele frequency was observed in young obese Algerian children (n=57) than in lean children (n=59). Although studies to date are limited and some findings are conflicting, it is important to characterise genetic variations to understand the role of genetic variation in fat perception diet in order to understand the development of diet-related health problems.

### Temperature perception

The temperature of food and beverages is very important for their acceptability; it can affect how foods are perceived from sensory perspective. It does not affect the physical properties of the products but it also affects human temperature perception. Interestingly, part of the population (between 20 to 50%) has an ability to perceive an extra-sensing for cooling their tongue and using people are called ‘Thermals’[42]. There has been no significant difference measured across different temperatures between thermal tasters (TT) and thermal non-tasters (TN). The orosensory system, which likely plays a role in taste temperature perception, has been proposed. The Amiloride-sensitive salt taste receptor (TAS2R38) has been proposed to function as an amiloride-sensitive salt taste receptor (TAS2R38) has been proposed to function as an amiloride-sensitive salt taste receptor (TAS2R38) has been proposed to function as an amiloride-sensitive salt taste receptor (TAS2R38) has been proposed to function as an amiloride-sensitive salt taste receptor (TAS2R38) has been proposed to function...
Staying in touch with food preferences

Introduction

When people talk about food, they do not usually mention how it ‘feels’ or the specific textures present. However, the reality is that the tactile properties of food are important in that they help guide peoples’ perception of food products. Everything people feel whilst eating matters, be it weight, temperature or texture. When discussing food and touch it is worth mentioning that there are multiple aspects of touch that help to generate specific food perceptions. Firstly, there is the most obvious kind of touch, the one we experience whilst eating, when areas in the mouth are actually touched by the food. Secondly, there is tactile input through our hands, i.e. how the food feels upon touch. Finally, there is the touch of the packaging which contains the food. All these areas contribute to the generation of food perception.

In the past few decades there has been a plethora of scientific evidence all pointing in the direction that touch is hugely influential in moulding consumer perception. The tactile cues are often not visually detectable; even if consumers can see the cues, they may not realise that they are receiving tactile information. Having a better understanding of this area can help marketers, food manufacturers and product developers to make food appear more appealing, to create an overall more rounded and interesting experience and to increase the likelihood of consumption. These days consumers are sophisticated and often have high expectations of their food.

This article provides an outline of some of the tactile research conducted to date that is applicable to further the understanding of tactile cues in food perception.

Cathrine V. Jansson-Boyd of Anglia Ruskin University discusses why the tactile qualities of food and its packaging are so important in determining how consumers perceive different foods.
Food and the touch other senses

When it comes to food, texture properties are closely connected to sound. It is important to recognize that most consumers do not experience different sensory inputs in isolation, but they are in fact processed simultaneously. This means that it is essential to understand how touch is influenced by input from other modalities. In particular, sounds that are related to food consumption, such as those heard whilst eating, may be linked to crispiness and freshness in chips, such as chips and carrots[14]. Interestingly, the perception of specific sound related properties can be altered by using tactile properties. For example, perceived crispness of chips can be altered by changing the sound of the packaging that people hold whilst eating, thus demonstrating that touch can be used as a tool to reinforce or alter a particular food-related sound, and by doing so, change perception.

When presenting consumers with multi-modal information, it is crucial that the combined sensory inputs actually generate the desired perception. Odour and taste are usually perceived together for food products and thus it is easy to imagine that if a food item tastes very different from the smell, it has a negative impact upon the evaluation of the particular food. This is also very much the case for touch and thus it is important to be aware of the kind of touch-related properties that are deemed to be ‘congruent’ with a food item. Whether this be the actual texture and temperature of the item or indeed the packaging in which it comes, it is important that these are perceived as congruent to ensure that a positive perception occurs. In regard to ‘congruent’ tactile properties, it seems that our expectations of how something should feel to touch is very much based on previous experiences. Thus, incongruity may in many cases be simply not the norm[12]. Hence, you may ask whether the feel of a bottle is actually going to reinforce the perception of taste (Figure 2).

Using tactile information visually

As we know, consumers normally rely on their visual input to make an instant overall assessment of a product. It is particularly applicable to fast moving consumer goods in that shoppers do not really have the time or interest to consider each one of their purchases individually. Hence, the best way to get a tactile message across is through the means of vision. There is currently limited research on exactly how to communicate tactile sensations to the consumer through visual vision, but it can be achieved[9]. One demonstration of doing so is by reinforcing key aspects of how the manufacturer wants the product to be perceived, for instance, as can be noted from Figure 2, by putting graphics on a package to indicate the crunchiness of the product.

The more visually congruent as the crumbs are on the packet, the more it can satisfy people who have a high need to touch (as this varies from person to person) and thus they can make a judgement in regard to how crunchy the biscuit actually feels. Consumers can therefore quickly see, but without having to engage in any extensive and tiresome mental elaboration, that the product is crunchy. Equally in terms of advertising, tactile cues can be used to remind people indirectly of what something may feel like, such as Andes toilet tissue using labrador puppies in its marketing campaigns to create a visual association between the softness of the puppy and the toilet paper.

Why touch is such an important sense?

There are several reasons why touch is such an important sense and in particular that are undoubtedly central to food perception:

1. Touch has the ability to alter the way in which food products are perceived because it can rapidly and correctly identify what something is[11]. This also seems to translate well into how people perceive food in their mouths. It has even been found that children who are more sensitive to tactile input in general are also more sensitive to tactile stimulation in their mouths. Thus, sensitivity to touch appears to play a role in acceptance of food[8]. If this relationship can be explored in more detail it might help to encourage young ‘fussy’ eaters to explore new eating patterns. Furthermore, it may be possible by a stepping stone to help those with more serious eating disorders to feel more comfortable consuming different types of foods.

2. Touch is connected to emotive experiences. There are now many neuroscience-based studies that clearly connect touch and emotion. Specifically, it seems that touch conveys a form of emotional attachment in consumers[10], which effectively means that consumers become more ‘involved’ with the products they touch. When people touch something, they base their evaluations on the emotions experienced. At least partially, this is likely to explain why touch tends to increase the perceived value of a product. ‘The fact that emotions are triggered by touch is not something that people are aware of, instead the emotions are experienced at a subconscious level. It is beyond the scope of this article to present all the scientifically based results that have emerged in the last couple of decades to provide a better understanding of how the tactile senses perceive consumer food perception. Nevertheless, it is important to be aware of the studies outlined that it can most certainly play a key role in how food is perceived. There are still some questions that need addressing before we have a clear picture of how to alter specific elements of touch, whether it be food texture or packaging, in order to get a desired outcome. But in the next ten or so years it is likely that a road map will emerge that can be used by food manufacturers and marketers who want to use touch as their chosen modality to communicate a specific food message.

Tactile cues of food

References and article available online at: psyccentral.com/journals/FS.T.JOURNAL.ORG

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Figure 2 Imagines that you are about to pick a bottle that is going to contain water that you are hungry. Which bottle would you pick? Does it matter what shape it is? Is it may feel to hold in your hand? What about the way it feels? Does the colour matter? Perhaps you would be more likely to pick a very soft bottle with water that you are hungry. The bottle is congruent with water. Neither is the shape of bottle B congruent with our perception of what a bottle looks like. Why would you pick the bottle that best represents the bottle from a visual and tactile perspective and ensure that they are congruent.

Figure 3 The pictures of biscuit boxes above, show a visual incorporation of tactile cues, ‘crumbly’, so that consumers are effectively informed that the product has a ‘crumbly’ texture.

While it may be obvious that products need to ‘look’ good, it is perhaps less obvious that textures can also influence the way in which products are perceived.

In a pioneering study conducted in 2007, a team from Anglia Ruskin University looked at the influence of touch upon aesthetic evaluation[4]. It was demonstrated that if you alter how products feel, the perception of attractiveness is also changed as a consequence of the texture modification (see Figure 1). Furthermore, previous experiences of how something feels are closely aligned with whether people think that an item is attractive. However, it was also found that touching something that feels highly unusual causes the attractiveness rating to decrease, but people do make more use of the tactile input to determine overall likability.

These findings have since been replicated using a wide range of products including food, and thus showing that it appears to be a rule that can be broadly applied to most product categories. For example, how food feels when touching it can modulate the oral perception of texture[5]. In this study participants bit into fresh or stale pretzels. The findings demonstrated that the tactile feel of the pretzel (while held in the hand) affects the way in which the pretzel is perceived orally. Basically, the softer the pretzel was in the hand, the staler it was perceived to be in the mouth, demonstrating the influence of tactile information on food perception.

Other researchers have also confirmed that how a product feels to touch, even though not directly related to the actual food or beverage, can affect perception of what is being tasted. For example, it was found that the quality of a cup from which people drank water changed their perception of the water. The water was viewed as being of better quality when participants drank it through a straw and were holding a taller and thinner touch or hold a flimsy plastic cup in which the water was served

Other studies have also identified that components, such as the shape of a wine glass, can affect flavour release and that shapes and sizes of containers can play a role in how much of the content is consumed. Similarly, this has been found for other products and at times it can even impact on satiety. This demonstrates that the choice of packaging materials is important as it is a determinant of product perception.

It is important to be aware of the kind of touch-related properties that are deemed to be ‘congruent’ with a food item. Whether this be the actual texture and temperature of the item or indeed the packaging in which it comes.
A salt on the senses

Sineenath Sukkwai, Kongkham Kjorongjongana, Napapan Chokumnoyporn, Sujinda Srivattana, Damir D. Torrico, Kairy D. Pujols and Wilton Priyawiwathil report recent research on consumer responses to different sodium reduction approaches. They discuss the potential for using sensory science as a tool to achieve salt reduction in foods.

Introduction

Salt (NaCl) is essential for normal functioning in humans and the second most used food additive. However, high sodium (Na) consumption is a major contributor to high blood pressure. Globally, correlation exists between excessive sodium consumption and high blood pressure, which leads to possible heart disease, stroke, heart and kidney failure. In the United States, the average daily Na intake is more than 3,400mg (equivalent to 8.5g salt), which exceeds the current maximum recommended intake level (2,300mg/d Na or 5.8g/d salt) established by the 2005 Dietary Guidelines for Americans.

Individuals aged 51 years and older, and those of any age who are African American, or who have hypertension, diabetes, or chronic kidney disease should have hypertension, diabetes, or are African American, or who have hypertension, diabetes, or chronic kidney disease should limit their Na intake to 1,300mg per day. In the US alone, more than 800,000 people die yearly from heart disease, stroke and other vascular diseases, costing a sum of $273 billion in healthcare dollars.

Awareness of potential negative effects of high Na consumption is critical for public safety.

Sodium reduction approaches

More than 40% of Na consumed originates from 10 types of foods, of which the top five foods are bread and rolls, cold cuts and cured meats, pizza, fresh and processed poultry, and soups. Moreover, 65% of Na consumed is present in retail foods and about 25% comes from restaurants. Reducing NaCl is a challenge faced by the food industry. The most evident role of salt is to make food taste pleasantly salty: salt is a multifunctional ingredient that can also act as a preservative and a food flavor enhancer.

Busch et al. described the three recent major approaches to reducing sodium in foods as chemical mechanisms, cognitive mechanisms or modification of the food product structure (Figure 1). This article describes research work performed at the School of Nutrition and Food Sciences (SNFS) at Louisiana State University (LSU) and its collaborators, following these three approaches.

i. Chemical approaches

Potassium chloride (KCl) has commonly been used to substitute for NaCl due to their similar chemical and physical properties. Low-sodium products (>140 mg Na per serving) containing KCl are usually less desirable due to bitterness and metallic-off-flavour. Kairy Pujols at LSU SNFS evaluated changes in overall-liking (OL), emotional response and purchase intent (PI) of low-sodium roasted peanuts as the added KCl concentration increased. Compared with the control (no KCl), adding 50-50% KCl did not significantly decrease OL scores (6.33 vs. 6.11-6.20) but the scores decreased (5.80-5.84) at 70-90% KCl. A PI of 64% was observed at 0-30% KCl and about 53% at 50-90% KCl. No significant differences were observed for positive emotions (energetic, happy and pleased) among all treatments. Adding more than 70% KCl decreased the ‘satisfied’ response. No consumer rejection threshold of added KCl was reached under the conditions of this study. This work demonstrated that low-sodium roasted peanuts containing KCl (replacing up to 90% of NaCl) with 138.9 mg Na/75g peanuts were acceptable to consumers. Using KCl can reduce the Na intake level and increase the K intake, which may help to reduce the problem of elevated blood pressure. However, KCl elicits salty taste but also imparts an unpleasantly bitter taste, hence a bitterness blocker may be needed.

ii. Modification approaches

Using KCl can reduce the Na intake level and increase the K intake, which may help to reduce the problem of elevated blood pressure. However, KCl elicits salty taste but also imparts an unpleasantly bitter taste, hence a bitterness blocker may be needed. Several bitter tastants. Pamarin compound shown to block bitterness by binding at the receptor site as well as an interaction between the guanidinium side-chain of Arg and the sodium channel in the human taste bud. It may enhance saltiness of NaCl.

Waimaleongara-ek evaluated several bitter tastants. L-arginine (Arg) masks bitterness by binding at the receptor site and the sodium channel in the human taste bud. It may enhance saltiness of NaCl.


d0.002 to 0.0005...}
which, in turn, largely decreased concentrations significantly (HC) (Figure 4).

emotion and purchase intent statement on expected saltiness colourant concentration and a et al.

prefer natural colourants to-focused on association of colour food products. A combination accounted when utilising OISE in may become less effective at a odour could induce and enhance al flavourings. Chokumnoyporn sauce is one of the most popular in the mouth. However, relatively mechanisms in the brain and not multisensory-integration that odour induces saltiness researchers have proposed and psychological effects but the physicochemical, physiological perception. Odour and taste Several studies have evaluated II. Cognitive approaches

increased with increasing scores decreased while the (good, interested, satisfied) positive PI. Positive emotion (good, interested, satisfied) decreased guiltly and unsafe scores but minimally affected PI of NC and MC. Saltiness expectation was not different between NC (light orange) and between NC vs. HC (darker orange), respectively.

demonstrated that soy sauce odour could induce and enhance salty taste perception in water with undetectable salty taste and salt solution, respectively (Figure 3).

Increasing soy sauce odour concentrations increased acceptable salty taste perception. However, OISE may become less effective at a higher salt concentration. This finding should be taken into account when utilizing OISE in development of reduced-sodium food products. A combination of OISE and other approaches should be considered in an effort to reduce sodium intake.

Many studies have reported effects of colour on perception of tastes and their intensities, however, very few studies have focused on association of colour with bitter and salty taste qualities. Nowadays, consumers prefer natural colourants in synthetic counterparts. Sukuluvai et al. evaluated the effects of colourant concentration and a colourant with a ‘natural source’ statement on expected saltiness intensity, sensory liking, emotion and purchase intent (PI) of dipping sources containing no-colourant (NC), moderate-colourant (MC), high-colourant (HC) (Figure 4).

Increasing colourant concentrations significantly decreased overall liking scores, which, in turn, largely decreased positive PI. Positive emotion (good, interested, satisfied) decreased guiltly and unsafe scores but minimally affected PI of NC and MC. Saltiness expectation was not different between NC (light orange) and between NC vs. HC (darker orange), respectively.

however, consumers expected HC to be saltier than MC. Sukuluvai et al. further reported that statements of ‘natural colourant’ and ‘medium content claim’ (regular salt, RS = NaCl, reduced-sodium, RoS = KCl, no salt, NS) had minimal effect on elicited emotions. As salty taste may not be evaluated with a particular colour and this association is dependent on food types, more research is needed to further explore relationships between visual colour cues and salty taste expectation, which may be beneficial to the current effort of stepwise sodium reduction in retail foods.

of critical sensory attributes to attain an optimal sensory profile (Figure 2) (within the yellow shaded area) that would yield low sodium cheddar cheese formulations with acceptable sensory qualities (scores 1.5-3.0 on a 5-point hedonic scale).

Table 2 Some psycho-chemical properties of commercial salt and foam-meat salt

Table: 1

PHYSICO-CHEMICAL PROPERTIES

COMMERICAL SALT

FOAM-MAT SALT

Average particle size (µm)

3382 ± 2.7

1338 ± 0.7

Appearance of salt

Scanning electron microscope (SEM) image

1. Modification of the food product structure

Busch et al. stated that the modification of the food-product structure itself can improve the perception of saltiness. In this article, we investigate the following: (1) modifying the salt crystals through changing their size, shape and morphology and (2) modifying the sensory properties of the food, such as oil-in-water emulsions.

Chokumnoyporn et al. [17] investigated the combined effect of OISE and foam-meat salt on saltiness perception and sensory acceptability of oil roasted peanuts. In this study, foam-meat drying was used. The salt solution containing a foaming agent was first whipped to a foam, then dried in a stream of warm air. The foam-meat salt had a bulk density about two-times lower than the commercial salt and had a smaller particle size (34.94-265.07 µm) compared to that of the commercial salt (170.78-529.55 µm) (Table 2). A sensory descriptive panel evaluated roasted peanuts seasoned with the control (commercial salt, 100%), C50 (commercial salt: soy sauce odour; 50:50) or F550 (foam-meat salt: soy sauce odour; 50:50) and reported the perceived saltiness enhancement of F550, which was likely due to the smaller particle size of the foam-meat based in OISE effect imparted by the soy sauce odour. F550 roasted peanuts had 10 mg of sodium per 100 g of sample less than C50 but were as acceptable as the control.

Modifying some emulsion characteristics including flavour, fat oil content, viscosity, droplet size and the type of emulsifier may affect the sensory perception of emulsions. Saltiness of NaCl and KCl, and bitterness of caffeine were evaluated in emulsions in prepared with varying oil (20/40/60%) and salt (NaCl 0.50/0.75/1.00% or KCl 0.50/1.00/1.50%) concentrations by a sensory descriptive panel and at e-tongue [15,16]. At a given constant concentration, NaCl had higher saltiness intensity compared to KCl in emulsions. Increasing oil concentration increased saltiness of both NaCl and KCl (Figure 5b), while it slightly increased bitterness of KCl in emulsions (data not shown). Saltiness enhancement of NaCl and KCl impacted by oil was more pronounced between 20 and 40% oil. E-tongue saltiness measurements corresponded to those of the descriptive data (Figure 5c,d).

Viscosity was the discriminating property among emulsions and possibly contributed to changes in salty and bitter perception. Torrico and Prinyawiwatkul [10] further reported that increasing oil concentrations affected consumers’ taste perception (saltiness and bitterness) of mayonnaise spreads. Cerrato Rodriguez [11] confirmed that the type of oil (e.g., olive, rice bran, and soybean oils) had significant effects on bitterness and overall taste liking of mayonnaise-type spreads.

These findings are useful for understanding consumer taste perception of oil-in-water emulsion products.

Conclusions

Excessive sodium intake is observed worldwide, hence there is an urgent need to reduce sodium in diets. Sodium reduction is an important public health priority that should be addressed by coordinated efforts at multiple levels of government authorities, food industries, educational entities and other diverse stakeholders.

Reducing sodium in the food supply is feasible and will increase consumer choices. It will save thousands of lives and health-care expenses each year. This article demonstrates the importance of sensory science as a tool for salt reduction in foods.
From pixel to plate

Introduction
Beyond personalisation, digital tools can elevate and change our perceptions of food by influencing how we perceive the taste, look and smell of what we eat.

Everyone has an opinion on food. We all have our favourite foods, comfort foods and adventure foods. Despite all this enthusiasm and interest however, the kitchen space has remained relatively unchanged, especially in terms of technological innovation. We still have microwaves and food processors, but digital technologies have not really made it into people’s homes yet.

The culture of food preparation and consumption is changing. Different edible materials and techniques can be used to create multi-dimensional food experiences. In this article we will explore how 3D printing can be used to enable multisensory dining.

Digitising food
People connect through food. Some love cooking and sharing food, and most of us love consuming it. But with our busy lifestyles, we have less time for cooking and less time to think about nutrition and the health benefits of the foods we consume. Additionally, pressures on our free time give us fewer opportunities to explore and enjoy our food.

We eat for both necessity and pleasure. We seek out new experiences with food that are different, intriguing and unexpected. We find thrills in the flavours of dishes themselves. The context and tools that we use for eating all matter. According to Charles Spence, a psychologist and gastrophysicist from Oxford University, eating is a multisensory experience. Food usually stimulates all our senses: the sight, sounds and aroma as food is prepared, how the food looks, tastes and smells once it is ready, how it feels in your mouth, even the painful burn or tingling associated with some foods after you have eaten.

With multisensory dining, we aim to broaden our enjoyment beyond the taste itself to include sight, sound, touch and smell so that we are fully immersed in the experience as we eat. We can use digital technologies, such as 3D printing, to design fuller sensory experiences, where we can create different shapes, textures and even introduce aromas as part of the process.

Digitisation can help us personalise our nutrition, so we produce and consume just the amount of food that we want. Making food on demand in a portion of any size is very appealing if we want to reduce our carbon footprint and overall waste. Similarly, we can also enable positive changes to the production and delivery process as 3D printing can use fruit and vegetables that are juiced or pressed. This reduces wastage and is cheaper and easier to store and transport. 3D printers in our homes can essentially ‘reconstruct’ food from this juice or puree.

From a multisensory perspective, we could also reconstruct our source food into something else, for example convert a strawberry into a snozzberry. Dovetailed, a design studio and innovation laboratory, has been exploring how 3D food printing can be used to digitise food. It has been investigating how to design small morsels that are edible but where shape, taste, texture and aroma can be controlled. It has designed and built a printer that can make small, but juicy and delicious, flavour bites. Using a smartphone app we can design whatever our imagination can come up with.
3D printing can be used as a way to separate flavour, aroma, shape and texture and use them as individual aspects for design. For example, unwanted aromas associated with a dish can be replaced with new ones designed to deliver specific food experiences. Similarly, flavour, shapes and textures can be personalised.

Food thrill seeking
Food thrill seeking leads to the exploration of new tastes and environments. In London alone, there has been a proliferation of pop-up restaurants that boast unusual food experiences that go beyond taste. These range from drinking wine through straws that are metre long to eating in the sky while your chair is suspended 200ft up in the air by a crane. Dovetailed has been exploring how to represent and moderate emotions through taste and shape, for example by printing flavour hits that lift people’s moods. The aim is to better understand how different aspects of food and flavour can potentially fine-tune our emotional wellbeing.

Food is a glue that brings people together. We enjoy experiences where food is served in a new and interesting environment, for example Edible Cinema in London, where you receive a tray with numbered boxes containing food before the film starts. Then throughout the film, you are prompted to open different boxes and eat the contents to enhance the scene. It not only engages your sense of sight and sound, but also your taste-buds. A curator can now elevate the fear in a horror movie through adding taste and smell.

For fine-tuned multisensory dining, the Gastronoffs chef’s table by Joesf Youssef uses sounds and lays food out on a plate in a way that influences the intensity of the flavour of each dish. Inspired by Charles Spence’s research, it aims to change the perception of taste by pairing music with the right food or uses colour as seasoning to elevate our taste experience.

For food thrill seekers, chefs and mixologists can design and prepare tasty nibbles. But if you’re keen to try to create the experience yourself and explore, then using 3D food printing technology to create multisensory meals can open up new options. 3D food printing can release flavours at just the right time to make the experience count, the intention being that any experience can be elevated through taste, smell and visual presentation. 3D printing robots enable that delivery to be effortless and fun.

New digitally-enabled 3D printing technologies are enabling us to explore different experiences and be creative. They allow experimentation with the perception of taste and smell in the comfort of our own home. Imagine making an apple that smells like an orange, but when you bite into it you taste a tomato.

Conclusions
3D food printers are enabling us to be chefs and mixologists in our homes, creating new dining experiences that influence our perception of taste and creating multisensory dining through curated aromas and presentation. In the future, 3D printers will support our desire to prepare and cook food in exciting ways, helping to make healthy eating simple. These machines will become more and more sophisticated over time, allowing for the creation of multidimensional textures, flavours and aromas in a single bite.

This technology can also personalise our cooking by making use of the data we have collected about ourselves through various trackers and lifelogging. For example, data about our physical activity or our sleep could influence the design of daily bites packed with all the nutrition essential for keeping us going physically.

Digital technologies will help us to design food that cheers us up or evokes good memories. It will also allow us to make food for ourselves and others remotely. For example, could sending an instruction to your loved one’s 3D printer to print a strawberry heart replace sending a bunch of flowers? In the future, will we send edible versions of a text emoji, or Flavour-mojis, to express our feelings?

Left: nūfood 3D printer and app – printing edible heart from beetroot. Copyright The Stylist magazine

References and article available online at fstjournal.org/features/printed-food

Dr Vaiva Kalnikaitė
Founder and CEO, Dovetailed
Cambridge, UK
Dovetailed is an award-winning human-experience design studio and innovation lab bringing science and design together to create future experiences today. Our work spans from design for AI and design of physical and digital products and services to creating multisensory dining experiences with the help of technology. We are currently funding research into the use of 3D printing for future interactions with machines as well as researching the role of emotion and memory in the context of taste perception. Vaiva is also the inventor of nūfood, the world’s first 3D food printer for printing with edible liquids. She leads a multidisciplinary team that works on a range of projects from designing human-centred AI to understanding how shoppers can interact with smart fridges. She has been an invited speaker at various events including the Smart Kitchen Summit in Seattle, Engadget Expand in New York and Mobile World Congress in Shanghai. She is also an RSA fellow.

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The UK context for PFNs might be relatively straightforward and simple to ensure that smaller UK food producers remain motivated nationally. He welcomes the initiative but is wary about the spread of PFNs beyond the original EU scheme. He believes that they are far more used to the scheme as they have been using it for years. The companies applying tend to be larger, with support organisations regionally and nationally. He welcomes the initiative but is wary about the implementation and practicality and stresses that systems need to be relatively straightforward and simple to ensure that smaller UK food producers remain motivated for success. The E3S PDO working group has recently launched a project to prepare a guideline for accreditation of PFNs in the UK. This initiative is expected to run for two years, with plans for a first draft of the guideline to be presented at the European conference in Verona in 2018.

**Sensory guideline for PFNs and the UK context**

The UK context for PFNs might be seen as different from that in many other EC countries, as there is less awareness and take up of the scheme in the UK. The focus for much of the promotion of the PFN scheme in the UK is towards smaller producers. This might result in a tailored implementation approach for the guideline in the UK.

According to Matthew O’Callaghan, Chair of the UK Protected Food Names Association, in countries such as France and Italy, there are many food manufacturers participating in the EU PFN scheme. He believes that they are far more used to the scheme as they have been using it for years. The companies applying tend to be larger, with support organisations regionally and nationally. He welcomes the initiative but is wary about the implementation and practicality and stresses that systems need to be relatively straightforward and simple to ensure that smaller UK food producers remain motivated.

**Introduction**

Provenance and tradition have become mainstream concepts in the food and drink industries and are often associated with high quality products. Regional and traditional foods represent an important element of the food and drink economy in some countries and can offer an opportunity for niche products. The EU Protected Food Name (PFN) scheme is a system for guaranteeing the authenticity of regional and traditional food and drinks. The UK is currently a member of this scheme. Although sensory aspects of PFN foods are integral to their authenticity and quality, there is currently no common/generic official guidance as to how to determine, ensure, or monitor the sensory properties. The European Sensory Science Society (of which the IFST is a member) is seeking to address this situation by creating a guideline for the accommodation of protected products by sensory analysis.

**Background**

Three levels of protection are currently available:

- **Protected Designation of Origin** (PDO) — for a product produced, processed AND prepared in one area and having distinct characteristics from this area. The product must be made using distinct local knowledge.
- **Protected Geographical Indication** (PGI) — for a product produced, processed OR prepared in the geographical region associated with it and having a reputation, characteristics or qualities as a result of the area associated with it.
- **Traditional Speciality Guaranteed** (TSG) — for a product with a traditional name and characteristics that distinguish it from other similar products. The characteristics cannot be linked to the area where the product is made or to technical advances in production. TSG products can be made in any country in the EU.

PDO and PGI status mean that there is protection from imitations of the product being produced elsewhere and sold under the official name. PFN products must display the EU logo that applies to the protected food product on the food label.

This scheme has been running since 1992 and can be seen as equivalent to a type of intellectual property. Studies have shown that PFN schemes contribute to sustainable rural development and PDO/PGI products are known to contribute billions of Euros to the EU economy17. According to the Department for Environment, Food and Rural Affairs (Defra)18, as of February there were 85 protected food names in the UK including food products, wines, beers, ciders, spirit drinks and wool. Some examples include Beacon Fell traditional Lancaster cheese (PDO) and Melton Mowbray pork pies (PGI).

**Sensory descriptions of PFN**

The application to obtain EU PDO or PGI classification can be made by an individual or a trade group. A specification needs to be developed and it should include the product name, the area associated with the product, a proof of the product’s origin, the method of production, an explanation of the link of the product to the area and a description of the product. The description should give details of the raw materials and the main physical, chemical, microbiological and organoleptic (sensory) characteristics. The applicant must also nominate an inspection body which will check that the product matches its description. The specification for TSGs is slightly different and does not refer to an area associated with the product.

Although the sensory properties are quoted in the PFN specification, there is currently no common official guidance as to how products should be evaluated and what the format of the end description should be. Sensory descriptions in the specifications of UK PFN registered products can vary in presentation and level of detail. In addition, the process and methodology used for inspection/accreditation of sensory properties is not specified.

**Guideline for the sensory analysis of PDOs/PGIs**

The European Sensory Society (E3S) PDO working group has the aims of promoting the knowledge and application of sensory analysis to PDO products. Traditional local foods can also be considered but the stress is placed on PDOs. This working group is a network of sensory scientists interested in the PDO accreditation process, who are aiming to improve the professional status of members, enhance the knowledge of PDO characteristics and generate results useful to both producers and consumers. The E3S workshop is expected to produce a guideline for accreditation of PDOs and PGIs by sensory analysis.

The work is being carried out in conjunction with the European Accreditation Organisation and other relevant organisations regionally and nationally. The reference document for the project is the EU Publication Reference EA-4/09 G2017 ‘Accreditation for sensory testing laboratories’. It is envisaged that the guideline will include annexes with examples applied to specific classes of products (for example cheeses, cured meats, or wine). The project is expected to run for two years, with plans for a first draft of the guideline to be presented at the European conference in Verona in September 2018.

Carol Raithatha discusses progress towards developing a sensory evaluation guideline as a part of the accreditation process for Protected Food Names (PFN) in the UK and the EU.
to apply for and participate in PFNs schemes. He explains that part of the problem of trying to get protected food names registered is engaging small producers, which can be off by bureaucracy.

**PFNs and Brexit**

The UK application process for PFNs has two levels – UK approval followed by EU level approval. According to Defra, the entire process of getting a food or drink name protected can take up to four years. Given the current political situation in the UK, it is important to consider how Brexit will affect the PFN accreditation process. There are currently many unanswered questions, but the main options for the post-Brexit scenario are likely to be:

- **Option 1:** The UK will continue to use the current EU system and therefore the situation for PFNs will remain the same as at present. The benefit would be that current UK PFNs will continue to be viable throughout the EU. Future applications would also be possible. There is a precedent for countries outside the EU receiving EU PFN status for their products. For example, Thailand has four products (rice and coffe) with PGI registration in the EU scheme.

- **Option 2:** The UK will create its own PFN system that is compatible with and includes reciprocity with the current EU system, although it may not be exactly the same. The situation for the operation of the PFN scheme in this scenario would be similar to the present one. For example, since 2011, Switzerland has had a system that was developed to be EU compatible and ensure reciprocal recognition and protection. The benefit as above would be current UK PFNs would probably continue to be viable throughout the EU, but there would be some flexibility in the design of the scheme. Future applications would also be possible. The EU has concluded agreements that include geographical indication protection with many trade partners other than Switzerland (including Canada and Korea). The level of protection granted varies by agreement.

- **Option 3:** The UK will create a PFN system that does not include reciprocity with the EU system. The implications of this are unclear but might mean there is some difficulty in exporting some UK products to Europe, although European products would probably be allowed into the UK regardless of their PFNs. In addition, this would likely leave many traditional UK foods struggling to compete with larger producers. This option appears to be the least likely to occur.

**Stakeholders, such as the National Farmers Union, are lobbying for a continuation of food name protection in the UK after Brexit and have asked Defra to clarify its plans in this area.**

Stakeholders, such as the National Farmers Union, are lobbying for a continuation of food name protection in the UK after Brexit and have asked Defra to clarify its plans in this area. A UK Government minister has described the protection of British food as an extremely important issue and said that she hopes that at British PFN scheme will be introduced in place of the current EU one. This looks likely, as in an interview in January 2018, Michael Gove, the UK Secretary of State for Environment, Food, and Rural Affairs, stressed the vital role that PFNs play in the UK’s global food reputation and indicated that the Government is committed to upholding protection when the UK leaves the European Union. According to U Callaghan there are two types of producers within the scheme currently in the UK: those relying on it (in the absence of any other specific UK laws) for protection in the UK (for example Molten Mowbray Pork Pies and Cornish Pasties) and those who are more concerned about their ability to sell into Europe (for example Welsh Beef and Lamb and Anglesey Sea Salt). He stresses that the design of a PFN scheme in the UK after Brexit needs to be as seamless as possible with the current system.

The IFST is keeping a watchful eye on developments within the PFN scheme, Stephanie Mitchell, Chair of the Sensory Science Group hopes that whichever option is adopted will allow for UK products to continue to be sold into the EU. According to Sam Jennings, Chair of the IFST Food Law Group, the option we end up with will depend very much on the deal agreed with the EU. The PFN scheme falls into the same situation as other issues relating to food regulation after Brexit. The biggest problem at the moment is the uncertainty about what the deal will be.
Livestock Excellence in Innovation

The Centre for Innovation Excellence in Livestock (CIEL) was the largest recipient of funding from the Department of Business, Energy and Industrial Strategy, receiving almost £30m in late 2015 through the Government’s Innovation Agency, Innovate UK. To maximise the impact and reach of this investment, twelve academic partners came together and matched the government funding to create a total budget of almost £70m to improve the UK’s capacity for livestock related research. Collectively, CIEL forms the largest alliance of livestock researchers in Europe and acts as a central hub to access world-class research facilities and technical expertise.

Collectively, CIEL forms the largest alliance of livestock researchers in Europe and acts as a central hub to access world-class research facilities and technical expertise.

Over 30 forward-thinking businesses have recognised the opportunity presented by CIEL to help them to grow through innovation. CIEL enables businesses to participate in collaborative R&D, taking advantage of new facilities and academic partnerships. Internal services, including project management and dissemination, are also available to members, which can be key in helping to secure grant funding. Delivered through an annual subscription model, members include SMEs, corporate businesses and trade/levy bodies who, via CIEL, participate in information exchange, sharing project ideas, technical expertise and business challenges within a confidential and knowledgeable environment.

New animal research facilities for UK business

In 2015, an extensive review with the wider livestock sector was conducted to identify where research infrastructure was lacking, out-of-touch with industry or in need of development to meet emerging technological needs. Funding was allocated across five sectors: dairy, beef, sheep, poultry (broilers and laying hens) and pigs, with spend in underlying technologies including genetic assessment, advanced imaging, precision feeding, analytical tools and new animal housing.

Funding has enabled the development of multiple facilities – both small scale research sites and pilot study-scale facilities – representing an intermediary between small-scale, highly controlled units for undertaking fundamental research and full commercial scale operations. This is helping to address concerns that results from small scale trials do not scale up as expected. In addition, funding has enabled the scale up of the national research herds/blocks (total number of animals available for research purposes), increasing the UK’s capacity to compete on an international level. Due to their flexible structures, CIEL’s facilities enable collaborative R&D across a wide range of challenge areas for livestock production. These ‘Grand Challenges’ include:

- Anti-microbial resistance
- Climate change
- Improving resources efficiency

This is a commercial dairying system designed to facilitate targeted research into health, welfare and nutrition using flexible pens for comparative studies. Robotic milking and online monitoring along with a conventional rotary milking parlour offers the opportunity to focus on improving cow health and welfare while capturing environment and milk quality data. Similarly, technology will be employed at Duchy College, where the focus is more on economic evaluation and knowledge exchange through development of their Dairy Farm 2050 to benefit farmers and dairy processors.

In a move away from intensive systems, CIEL investment at AFBI promotes research capability for more extensive livestock farming. It is expected that a stronger focus on costs of production will be needed to improve the profitability and competitiveness of many farms.

Funding has been allocated to support productivity leaps for beef and sheep sectors. Aberystwyth University (sheep), AFBI (beef & sheep), Harper Adams University (beef), Scotland’s Rural College or SRUC (beef & sheep) and Rothamsted Research (beef & sheep) have all jointly invested with CIEL to fund a diverse portfolio of research tools for innovation activity.

Improving nutritional efficiency, considered crucial for meat production, is a key engagement with dairy farmers/end-users groups.

At Nottingham, the Centre for Dairy Science Innovation (C-DSI) is a commercial dairying system designed to facilitate targeted research into health, welfare and nutrition using flexible pens for comparative studies. Robotic milking and online monitoring along with a conventional rotary milking parlour offers the opportunity to focus on improving cow health and welfare while capturing environment and milk quality data. Similarly, technology will be employed at Duchy College, where the focus is more on economic evaluation and knowledge exchange through development of their Dairy Farm 2050 to benefit farmers and dairy processors.

CIEL forms the largest alliance of livestock researchers in Europe and acts as a central hub to access world-class research facilities and technical expertise.
theme for investment for both beef and sheep. As for dairy cattle, ‘Precision Feed’ stations at AFBI measure feed and water consumption for beef and sheep. Providing rich data about feeding behaviour, gut health changes and feed conversion studies. At Harper Adams University, the Beef Grower Finisher System will enable feed and water intakes for individual cattle to be measured, with sensors systems enabling measurement of greenhouse gases.

The North Wyke Farm Platform (part of Rothamsted Research) is considered the most highly instrumented farm in the world. This allows for further characterisation of the impact of ruminate livestock on the land by coupling three self-contained ‘farmlets’ with ‘an analytical laboratory to measure changes to soil, water and air. This enables researchers to measure the loss of nutrients or veterinary chemicals (including antibiotics) to the air, soil and groundwater, as well as the impact of particular feeds on greenhouse gas (GHG) production.

Similar technologies to measure feed intake are being employed for sheep at Aberystwyth, with in-depth studies of animal nutrient cycling through use of the Small Ruminant Platform. This enables the study of metabolic change within the rumen to assess feed additives or develop new pharmaceuticals, along with highly accurate environmental impact assessments.

Gut health can be probed through use of a library of rumen-derived anaerobic bacteria and fungi, supporting mechanistic studies investigating improved feed efficiency and/or GHG production. At the opposite end of the production cycle, CIEL and SRUC have co-funded a mobile CT scanner for high resolution assessment of sheep (or pig) carcass and body composition. Sedated animals can be scanned to assess carcass composition or body energy reserves to provide data into breeding programmes or to more accurately assess change for animals on different trials. Traits of interest include muscle mass and shape, back fat depth or body condition, meat marbling or skeletal structure. To date, the mobile CT scanner has already been used to scan breeding stock of multiple livestock species, along with meat products, fish and wildlife specimens.

One area of expertise is animal biomechanics, with investment in a state-of-the-art animal gait laboratory.

Poultry

The poultry industry is typically seen as the most innovative and forwards facing farm livestock sector, further research is required to unlock the genetic potential of multiple current bird breeds and reduce the impact of avian diseases. At the University of Bristol, eight experimental rooms (with tens of thousands of birds) have been constructed to bridge the gap between typical bird breeds and reduce levels of piglet mortality. For research into pig nutrition, new electronic feeding stations at AFBI enable the choice of multiple diets. Coupled with infrared cameras, imaging enables non-invasive measurements of physiological conditions and can be applied to studies of feeding behaviour.

Non-agricultural facilities

Whilst much of the funding has been spent on improving the UK’s capacity to deliver applied livestock science – either through on farm developments or new kits – CIEL is also committed to improving farm performance through impacts on animal health and food quality or developmental biology, helping to advance the One Health agenda on farms. For studies post farmgate and overseas – to develop new diagnostic tools and in adding value to existing projects through comprehensive market analyses and industrial dissemination.

The creation of a bespoke cloud-based portal to develop and manage innovation projects also enables real-time sharing of information – both of market and funding information – while driving development and streamlining the delivery of innovation projects. This service, offered exclusively to members, acts as an extension to business R&D departments and provides a simple framework for evaluating the merits of potential projects.

The Agri-Tech Centres were established to bridge the gap between applied science and practical agriculture. Their focus is to build collaborations and drive greater efficiency, resilience and wealth across the agri-food sector. By bringing together businesses and researchers, the Centres are helping to create a new collegiate culture to tackle real-world challenges and have set the foundations for the UK to become a leading force in AgriTech and food science.

References and article available online at psjournal.org/features/30-2/CIEL

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Seafood sustains a healthy diet

Charles Odilichukwu R. Oplaka of the Educare & Skills Training Network and Ivan Bartolo of the Sea Fish Industry Authority discuss the desirability of seafood consumption and its merits for healthy living.

Introduction

Global seafood production and its consumption have been of increasing interest and diverse health benefits have been established. Whilst consumers see the desirability of seafood from different perspectives, many are inclined to focus on the merits/positives while others are concerned about the demerits/negatives. This article assesses some key facts of seafood desirability.

Seafood consumption: some basic facts

According to the FAO’s State of the World Fisheries and Aquaculture 2016, seafood production in 2014 reached 167.2 million tonnes. Of this, 146.3 million tonnes were for direct human consumption, with aquaculture providing slightly more fish than capture fisheries. The figure includes fish (marine pelagic, marine demersal, diadromous, freshwater), molluscs (bivalves, gastropods, cephalopods), crustacea (shrimps, crabs, lobsters, krill), other aquatic animals (aquatic mammals/pteles, echinoderms, jellyfish) but excludes aquatic plants (seaweed, microphytes). Globally the supply of seafood has seen sustained growth thanks to production increases, reduced wastage, better utilisation and improved distribution[1].

Seafood consumption gives manifold health benefits. Fish and shellfish are a rich source of easily digestible, high-quality protein containing all the essential amino acids. They are also unusually rich in long chain omega-3 fatty acids, various vitamins (particularly A, D, B6 and B12) and several minerals. All are required as part of a healthy diet. The intake of protein through seafood consumption is crucial for the health of inhabitants of countries where the total protein intake is low, as in some developing coastal states[2].

Compared to other foods, seafood consumption is driven less by taste preferences and more by social norms, moral obligation and health. Regular seafood consumption from childhood results in a positive attitude towards seafood consumption in adulthood, whereas lack of familiarity with seafood and an absence of a history of seafood consumption can lead to a less positive attitude. Other drivers that promote the consumption of seafood include taste, convenience, diet variety, nutritional value, health benefits and the availability of fresh (quality) product. Barriers towards seafood consumption include price, convenience, knowledge of fresh seafood products and their availability. Insufficient understanding of the benefits of seafood and concerns about sustainability and quality also lead to negative attitudes to consumption. Consumer age positively relates with frequency of seafood consumption; older people tend to eat more seafood[3]. Table 1 lists some of the attitudes of UK consumers towards seafood in the context of other proteins.

Attitudes to fish are known to differ between purchasers and non-purchasers. Some people are reluctant to consume fish because of perceived difficulty of purchase, preparation and cooking, and the perceived unpleasant properties of fish, such as the presence of bones and fish smells during cooking[4]. Fish processors and retailers are aware of these barriers and encourage seafood purchases by formulating boneless products, often flavoured with sauces and requiring minimal preparation.

Seafood preparation and presentation

Seafood is available to the consumer in many different formats. Unprocessed seafood is available live, fresh or frozen, and may be presented to the purchaser gutted, filleted, shelled, shucked etc., as well as still swimming in an aquarium. Because of its perishable nature, seafood is very often preserved – by salting, smoking, marinating, freezing and/or gel. In the West, we recognise surimi as the main ingredient of crab meat analogues, but in Japan, some South East Asian countries and in northern European countries, surimi is widely consumed as a food in its own right or is used to make fish cakes (kamaboko) and other products[5].

As consumers look for quicker meal solutions and new product ideas, kitchen-ready convenience foods based on seafood are a growing sector. In the UK, they have helped raise seafood consumption especially among younger age groups, who are aware of the health benefits and are also keen to avoid handling and preparing seafood.

Notwithstanding the growing popularity of Japanese-style surimi and related raw seafood products, the vast majority of seafood is cooked before it is eaten. Seafood is fried, baked, grilled, poached, steamed or boiled. The different cooking processes not only make the raw material more palatable but also destroy potentially harmful microorganisms and parasites, such as the Anisakis nematode. Fish intended to be eaten raw (e.g. sushi) or almost raw (e.g. salmon intended for cold smoking) needs to undergo a process, usually freezing, to inactive parasites and ensure they are not harmful.

Health aspects of seafood consumption

Seafood is an important constituent of many people's
Benefits of seafood consumption can include:

- Fish and shellfish are a rich source of easily digestible protein containing all the essential amino acids. This source of essential amino acids is critical for populations with high carbohydrate diets and with little access to animal protein.
- Fish and shellfish are rich in several nutrients including calcium, iodine, zinc, iron and selenium.

Some possible adverse health effects of seafood could include:

- Some people are allergic to fish, crustaceans and/or mollusks.
- Mercury (Hg) can accumulate in larger fish, such as swordfish. Because of this, pregnant women in particular are advised to avoid such species and to eat other fish instead.

Rethinking water use

Food and beverage production is a water-intensive industry, with water required for cleaning processes, as well as being a key ingredient in many products. This places high demand on municipal water supplies and makes the industry vulnerable to water scarcity. Taking steps to reduce reliance on mains water supplies can have long-term benefits for businesses, minimising supply risk, providing significant cost savings and protecting the environment.

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Simon Emms of Veolia Water Technologies explains the benefits of reducing reliance on mains water for food and beverage manufacturers.

Taking stock

The first step for any company looking to reduce its overall water consumption is to understand where that water comes from, how it is used on site, how much effluent this produces and the composition of the waste stream. When you consider that it costs twice as much to discharge water from the factory as it does to draw it from the mains supply, reducing water consumption is one of the main goals of managing water well.

Even simple changes, such as controlling the volume of water used for washing products or equipment, can deliver significant long-term savings.

Recycling

Once processes have been optimised to use as little water as possible, the next step is to look at how water can be retained onsite for as long as possible and reused or recycled across a facility. Although there is some reticence to this idea within the industry, mostly due to public perception issues, modern water treatment systems are extremely efficient and effective and can often yield higher quality water than municipal supplies. After all, every drop of mains water that has been reused and recycled at some stage.
It is important to stress that this water is not currently recycled into food production as an ingredient, although there may come a time when both companies and consumers are sufficiently confident in the technology to permit its use. However, treating wastewater to remove contaminants can still provide a valuable and cost-effective resource for alternative purposes, such as to feed boilers and cooling towers, or for washing down and cleaning.

**Energy from biomass**

The next consideration is the potential value of the ‘waste’ that remains after water reuse and recycling. Many food manufacturing processes – particularly in dairies and distilleries – produce wastewater with a high chemical oxygen demand. Biogas is a by-product of treating these waste streams and, once cleaned, it can be used to supply boilers or a more sophisticated combined heat and power plant. Many facilities can meet up to 40 or 50% of their total gas/energy demands in this way, significantly decreasing annual expenditure while reducing reliance on natural resources. In some instances, sites may be able to fully meet their energy demand and generate an excess of gas or electricity which can be sent back to the grid, providing an additional revenue stream. Some biological wastewater treatment processes also generate biomass that can be given or sold to local farmers as a nutrient-rich soil additive, further offsetting water treatment costs.

**Alternative sources of water**

There is one more way in which businesses can insulate themselves against the disruptions to water supplies caused by burst pipes or drought: by making use of alternative water sources. For example, rainwater or water from boreholes can be used in boilers or cooling towers with minimal treatment, providing a supply of ‘free’ water. For higher purity water demands, clarifiers, reverse osmosis systems and deionisers optimise reactor performance to remove up to 99% of the COD. A unique, patented mixing system ensures preferential removal of inorganic solids and enhances reactor performance to remove up to 99% of the COD.

A simple, effective application of anaerobic treatment with external crossflow ultrafiltration.

**Dairy case study**

**A global dairy company required an advanced wastewater treatment and water recycling solution for a new £250m dairy capable of processing one billion litres of fresh milk annually.**

The company was aiming to create the first zero carbon fresh milk processing facility in the world, using the best available construction techniques, process technologies and renewable energy opportunities.

Veolia provided a wastewater treatment plant to process 500m³ of wastewater, containing 5-4 tonnes of COD per day. At the heart of this solution is a Memthane® anaerobic membrane bioreactor, which combines the advantages of anaerobic treatment with external crossflow ultrafiltration.

A unique, patented mixing system ensures preferential removal of inorganic solids and optimises reactor performance to remove up to 99% of the COD. Following anaerobic processing, low-strength wastewater and grey water is treated in a reverse osmosis plant and recycled to the dairy for CIP (cleaning-in-place). In addition, the biogas generated by the process is used to fuel the on-site combined heat and power plant, helping the client in its aim to be carbon neutral.

**Adopting a long-term view**

Planning ahead is never easy, especially when capital investment is required to realise long-term gains, but there is clearly a solid business case for rethinking water use, in terms of both operational resilience and the financial incentives. However, it is vital for companies to put sustainable and cost-effective water management at the heart of their processes to protect themselves from the growing strain on this crucial natural resource.

Reducing, reusing and recycling water across a facility will not only provide immediate gains in terms of cost savings, it will also allow the food and beverage industry to face an uncertain future with confidence.
Food inspection technology

Given the direct health and safety implications, quality control in the food and drink industry is perhaps of greater significance than in any other industry. However, despite this importance, data suggests that the number of food and drink product recalls is on the rise.

The Food Standards Agency (FSA) identified an annual increase of almost 20% in the total number of food safety incidents reported to them during 2016/17 compared to 2015/16[1]. The FSA also reported a similar increase in the number of food product recalls, with the figure more than doubling from the relatively stable rate seen in 2013 and 2014[2].

For food and drink manufacturers, the direct cost of having to recall a product is significant. For example, Swancote Foods estimated a food recall relating to metal contamination in ready meal potato salads cost the company £500,000, despite the incident being contained with the UK. For multinational companies the costs can rise sharply. US Food Safety Magazine estimates the average cost to a US food company as $10m in direct costs. According to a report[3] by the financial services firm Allianz Global Corporate & Specialty (AGCS), the food and drink industry is second only to the automotive industry in terms of money lost through product recalls. The report places the figures at over $3bn in insurance costs over the past five years.

Various reasons are cited for the uptick in food product recalls, including tougher regulation, the increasing dominance of large multi-national corporations, increasingly complex global supply chains, the impact of competition and economic pressures, driven further by inflation and the impact of Brexit, are causing food and drink manufacturers to neglect spending on the required research and development to ensure tougher standards are met.

Whatever the specific reasons for the rise in product recalls, the cost to food and drink manufacturers is clear. However, the fallout from such an event extends far beyond the direct operational costs associated with managing the incident, such as notification of regulatory bodies and consumers, product retrieval, storage and destruction of the unsalable product.

The true cost of a product recall affects a company’s market value with brand damage an increasingly important factor. The damage to a company’s brand is now amplified by the use of social media in which reports of faulty products are quickly spread. The mainstream media is increasingly influenced by this, as evidenced by the widespread reporting[4] of the ‘hummus shortage’ last year following the recall of Sainsbury Dipping Company hummus from supermarkets because of a possible contamination risk. The implications of the associated brand damage can reach customers, potential investors and licensees, reducing the value of intellectual property associated with the brand, such as trade marks. The effect on consumer goodwill can impact the market value of the company long after the food safety incident has been addressed.

Food inspection technologies

It is therefore more important than ever for food and drink companies to think carefully about the protocols put in place for ensuring quality control. Fortunately, the rapid pace of innovation in the field of food inspection technology is allowing food and drink manufacturers to combat this risk by installing systems on their production lines that can identify potential issues with food quality before they develop.

Food inspection technologies allow for the real-time analysis of food products on the production line. Such non-destructive technologies overcome the disadvantages of conventional destructive testing as a greater proportion of items may be sampled without interrupting the production run or sacrificing stock to testing. Food inspection technologies include a wide range of techniques, such as X-ray inspection, optical imaging techniques, vision systems and hyperspectral imaging. The wide range of techniques being used and developed reflects the fact that identifying potential safety hazards in food is a challenging task, depending on the particular contaminant, the medium in which it is found and the presence of packaging.

Figure 1 illustrates the number of patent applications being filed for food inspection technologies and the number of granted patents being awarded in this field. The data shows that investment in patent protection has steadily increased in both numbers of patent applications filed and the number of patents granted for food inspection technologies since 2013 (when the horsemeat scandal shook consumer confidence in many well-known food brands). This demonstrates that the pace of innovation in these technologies is growing. It appears that food and drink manufacturers are recognising the importance of investing in research into inspection systems to mitigate the increasing risk of food safety issues.

One of the increasingly commonly identified by X-ray inspection systems, which rely on the differing density between the foreign body and the surrounding medium to detect contaminants on the production line. Considerable research has highlighted the potential of X-ray inspection for the grading of fruits, vegetables and grains, and detection of bones in chicken and fish. Some advanced X-ray inspection systems can simultaneously perform in-line quality checks detecting physical defects, measuring mass, counting components, identifying missing or broken products, monitoring fill levels and inspecting the seal integrity of packaging.

Furthermore, the move towards a greater degree of foil and metal packaging has meant some more mature detection techniques, such as metal detection, are no longer effective, whereas X-ray inspection provides the possibility of identifying contaminants within metal packaging.

Ishida has patented a series of technological developments in the image processing of X-ray images allowing the detection of a range of foreign objects with high sensitivity. The successful detection of foreign bodies using X-ray detection relies on the appropriate selection of the required filters for the type of objects and product. Ishida has patented a system[5], which automatically selects the optimum combination of filters and image processing parameters to differentiate between foreign

![Figure 1: The numbers of patent applications and granted patents for food inspection technologies 2006–2017](image-url)
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Gill Jennings & Every LLP are a specialist Intellectual property firm providing commercially focused advice on legal protection for innovations and brands to companies ranging from start-ups to multinationals. A team of patent and trade mark attorneys specialises in advising clients in the food & drink sector.

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The last few years, significant progress has been made in the development of technologies to detect such contaminants in real time production line inspection systems. Hyperspectral imaging

Hyperspectral imaging is one such technique, which is seeing significant innovation in the food inspection industry. The method relies on the varying interaction of different molecules with light and therefore provides a non-destructive technique, which can in theory be implemented on the production line. Different molecules absorb and reflect different wavelengths of light such that, by illuminating a specimen and measuring and processing the reflected spectra and images, a vast amount of information about the constituent molecules can be determined[8]. The processed image information can be used to determine the presence of microorganisms, hazardous chemicals and even freshness of meat or the ripeness of fruit – in addition to identifying the physical contaminants currently identified via X-rays.

Such is the versatility of the technique that many are predicting that hyperspectral imaging will replace all existing inspection systems and will one day eventually be used by consumers themselves when purchasing food products to determine their quality. There is no doubt that the pace of innovation in this field is rapid, as demonstrated by the increasing patent applications being filed and granted for hyperspectral imaging technologies over the last ten years (Figure 2).

There are several technical problems to solve before the uptake of hyperspectral imaging becomes widespread. These issues include the amount of data processing required and acquiring the libraries of signals representative of the different molecules such that they can be reliably identified. However the possibilities provided by the technology are so great that there is a clear motivation to manufacturers to develop and protect the variant of the technology that emerges as the most commercially viable, driving the innovation illustrated in Figure 2.

Conclusions

Given the increasing standards expected of food producers and the amplification of the impact felt due to the prevalence of social media, the increasing trend in food safety incidents is unlikely to change for some time. It appears that increasingly food and drink manufacturers are recognizing that investing in food inspection technology at the point of production is necessary to manage the significant risks and ensure product quality is maintained. Companies that manage to obtain strong patent protection for the next generation of food inspection systems are therefore likely to be well placed to reap the rewards of their innovation.

The Food Authenticity Network is a free toolkit that can help fight food fraud and build a more resilient food supply chain. It is a UK government-funded initiative that was born out of the 2013 horsemeat issue and brings together all those with an interest in food authenticity testing and food fraud mitigation.

The Network raises awareness of tools available to check for mislabelling and food fraud and ensures that stakeholders have access to a resilient network of laboratories providing fit for purpose testing for food authenticity, so that ultimately consumers will have greater confidence in the food they buy. This article reviews developments since May 2016 when we first told Food Science and Technology readers about the Network.

Website

The website will be three years

Over the last few years, significant progress has been made in the development of technologies to detect [biological and chemical] contaminants in real time production line inspection systems.

Figure 2 The numbers of patent applications and granted patents for hyperspectral imaging technology 2006-2017

Figure 2. The numbers of patent applications and granted patents for hyperspectral imaging technology 2006-2017.
Food Authenticity Network

Governance

Independent governance remains at the heart of the Network and the membership of the Management Committee has been widened to include Kaisa Kazimierczak, Senior Scientific Advisor in the Food Protection Science and Surveillance Department of Food Standards Scotland and Franz Ulbrich, Head of the Knowledge Centre for Food Fraud and Quality at the European Commission’s Joint Research Centre. The governance structure is shown in Figure 4.

Member survey

A member survey carried out in 2017 showed a very positive response from members on the impact they think the Food Authenticity Network is having against this original objectives for it (Figure 5).

Creation of a global Food Authenticity Network

The first two years of the project were funded by Defra, with the Food Standards Agency and Food Standards Scotland coming in to co-found the third year. We are now in the fourth year of the Network and the Department for Business, Energy and Industrial Strategy (BEIS) has also joined the government co-funding consortium. In 2018, the Network will transition from being solely government funded to an industry-led initiative seeking to build a truly global Food Authenticity Network by working with the food industry and other stakeholders from around the world and to grow it into a global Food Authenticity Network. If a truly global network is to be achieved, the Food Authenticity Network will require further funding.

We plan to raise the additional funding by asking stakeholder organisations to make modest contributions (which can be as little as £1K per annum) to support the growth of the Network, a cooperative funding model similar to that used by the Science Media Centre will be used. Setting up this model of funding to support the Network will allow it to operate on a long term sustainable basis, as envisaged by the Elliott Review and help all stakeholders to better combat food fraud.

Why should the Food Authenticity Network be supported?

• To ensure continued operation of a free, open access resource for all stakeholders, creating a living playing field
• To ensure members can keep up to date with the latest developments in food authenticity testing
• To help industry develop food fraud mitigation plans
• To help build capability and capacity in third countries
• To help improve consumer protection by fighting food fraud globally leading to more secure food supply chains and increasing consumer trust in the food they buy

What will supporters get?

• Affirmation that they support Food Authenticity assurance by contributing to the Network
• Use of our logo on their website and marketing material
• Listing, if desired, on the Network website
• Direct access to 14 Food Authenticity Testing Centres of Expertise
• Ability to post to the Network website

If you wish to support the Food Authenticity Network then please contact us to discuss this further.

by government to build a cost efficient model and this has been achieved, as the cost of running the Network, at a basic level, is only £900 per annum. We are delighted to announce that we have secured this underpinning level of funding from BEIS, which means that the Network can continue to operate as a free resource to all stakeholders on food authenticity testing and food fraud related matters until March 2021!

However, as food fraud is an international phenomenon that crosses borders, a truly global solution is required. The aim is to build on the current success of the Network, by working with the food industry and other stakeholders from around the world and to grow it into a global Food Authenticity Network. If a truly global network is to be achieved, the Food Authenticity Network will require further funding.

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Key

1 To improve communication on food authenticity issues
2 To act as a mechanism for dissemination of technical information on food authenticity
3 To act as a trusted source of curated information on food authenticity testing
4 To be an open forum for knowledge exchange
5 To help facilitate the advancement of new scientific approaches and techniques through discussion and co-operation
6 Helping to ensure fit-for-purpose methods are available

Figure 5 Member survey 2017

Food Authenticity Network

Guides

1. Premium lab’s guide to preventing food fraud
2. USP Food Fraud Mitigation Guide
3. CIEN Counter Fraud Good Practice Guide for Food and Drink Businesses
4. Food Supply Chain Vulnerability: A T appears in partnership with ROA Group
5. Guidance on Authenticity of Herbs and Spices: Industry best practice on assessing and protecting culinary dried herbs and spices
6. Guide to working in partnership with the UK National Food Crime Unit
7. PAS 96:2014, Guidance to protecting and defending food and drink from deliberate attack
8. FDF Food Authenticity Guide 2014

Reports

1. Thinking like a fraudster – overview
2. Thinking like a fraudster – attack
3. Thinking like a fraudster – defence strategies
4. How do you use intelligence to defend against food fraud?
5. Michigan State University Food Fraud Initiative report – Applying Enterprise Risk Management to Food Fraud Prevention
6. European Commission’s monthly report on food fraud and authenticity

Food Originality Network

Virtual Food Authenticity Network

Adulteration Databases

1. Food Industry
2. Laboratories
3. Test kit producer
4. RM/PT provider
5. Media
6. Stakeholders
7. Other

Admission

1. Horizon Scan – Food Integrity Horizon Scanning
2. USP Food Fraud Database version 2.0
3. Food Industry Intelligence Network (FIN)
4. The Food Protection and Defense Institute’s Economically Motivated Adulteration Databases
5. The Food Protection and Defense Institute’s World Factbook of Food Fraud
6. PwC and SSAFE food fraud vulnerability assessment tool
7. Food Integrity Knowledge Base – EC CRC

Figure 6 Governance structure of the Network

LGC

Food Fraud Mitigation

Food Authenticity Network

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Figure 5 Member survey 2017

The Food Authenticity Network Team

Secretary Mark Woolfe, ex-Head of the Government’s Food Authenticity Programme

Infrastructure Manager Steve Ellis, Science Fellow at LGC

Communications Manager Felicite Golden, Media Relations Officer at LGC

Project Manager: Selvarani Ehlahi, Deputy Government Chemist at LGC

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web The Food Authenticity Network is free to join. Sign up at foodauthenticity.uk and follow us on Twitter @FoodAuthenticity

Figure 4 Governance structure of the Network

Figure 3 Services and information available through the website

Figure 2 Main features of the website

Figure 1 Member list of the Network

October 2014 and has grown substantially; there are currently over 820 members from 41 countries/territories (Figures 1a and 1b), and over 1,433 followers of the Network’s Twitter account. Figure 2 shows the main features of the website, which acts as a one-stop-shop for information on food authenticity testing.

The website also acts as an open forum for the interchange of information between members of the food authenticity community to resolve authenticity problems, in particular discussion of ‘fit for purpose’ methods and promotion of best measurement practice in authenticity analysis. It now includes a section on Food Fraud Mitigation, in which the major global services, guidance and reports aimed at preventing food fraud have been collated. The type of service and information available are shown in Figure 3, above.

Food authenticity method related information resources currently available on the website include research materials (101), methods (65), surveys (16) and nitrogen factors (22).

The Network’s aim is to keep members informed of new developments in food authenticity, new initiatives to investigate and prevent food fraud and major problems in the global food supply. To this end, to date, over 330 news items have been added and over 30 events advertised. As our global membership grows we will continue to report authenticity and fraud news from around the world.

Food Integrity Knowledge Base – EC JRC

Adulteration Databases

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Employers continue to outline the significant need to bring new recruits into the food industry for the future and food science graduates are a key part of this talent pipeline\(^1,2,3\). The aim of the project ‘Competencies for Food Graduate Careers’, developed in partnership with representatives from SMEs, retailers, manufacturers, R&D centres and higher education institutions, was to disseminate a competency framework tailored to typical technical career pathways for graduates entering the food industry\(^4\).

Forty-eight elements were identified and grouped into 8 themes (Figure 1) that identify not only knowledge but also a consistent and relevant set of behaviours and skills that are desirable in a food science graduate. A list of 14 typical graduate entry roles were also agreed by the industry stakeholder group (Figure 2).

An industry-wide survey in early 2017 gathered data (from 226 respondents) about the most desirable elements for each of the 14 roles. After detailed statistical analysis of the responses, a white paper was released later in 2017 on the IFST website\(^5\). It clarifies the elements and themes that are most desired for each of the roles using infographic posters to display the results (Figure 3). However, gathering this information was only the first stage of the project. Over recent months the results of the Competencies for Food Graduate Careers project have started to be utilised. They have been integrated into final year undergraduate teaching.

Emma Weston, Associate Professor, Division of Food Sciences, University of Nottingham, initiated a research project in 2015 to explore what makes a ‘great graduate for the food industry’ and how educators can optimise curricula to facilitate this. She describes the progress to date.

" Developing ‘oven-ready’ graduates in the food and drink sector"
at Nottingham, aiming to increase understanding of career pathways and allow preparation for job application and selection processes. Students have been positively engaged with the new material, finding it very useful. Feedback from the students suggests that ‘Information is clear to understand and includes all the competencies and skills that are required for the job roles. A wide range of roles and coverage and details are very in-depth and useful for building up your CV and preparing for interviews.’

Cardiff Metropolitan University has also introduced Competencies for Food Graduate Careers to all year groups studying Food Science and Technology degrees this year to assist them in planning and direction.

Dr Anita Setarehnejad explains, ‘Using this knowledge, students can prepare themselves for the career they would like to be in and focus on relevant module choices while studying to be in and focus on relevant students can prepare themselves explaining, ‘Using this knowledge, our courses are aligned to real needs and our students are better informed about career options. Based on their own experiences and strengths, they are now better prepared for success in interviews. Working with other universities on this project and providing an online resource for all to use demonstrates our commitment to supporting wider development of industry-ready graduates. An interactive online tool for all students to explore the types of competencies that are desirable for typical graduate roles and how their personal skills may be best matched to them is due for launch in early summer 2018 on the Nottingham University website. This tool will be accessible for students already studying Food Science related degrees at university, but also for prospective students finishing their schooling, who are interested in finding out about the exciting careers that the food industry offers. Once the tool is live, a link will be added to the IFST website.’

This provides a very comprehensive overview of the wide field of food waste valorisation, breaking down into many different food waste types, their compositions and options for valorisation based on both currently available technology and future projections. The result is a very useful go-to resource for anyone in the field for information and further reading.

There is some degree of inconsistency to the chapters, with some feedstocks receiving very in-depth treatment and others being given less attention than others. This also means that the technical detail varies from chapter to chapter, which may not be an issue for more well-versed readers, but newcomers to the area (e.g. first year PhDs) may well struggle to use the book as a stand-alone resource without other background reading. Conversely, more established readers may find the level of detail provided to be somewhat basic and are unlikely to gain any further insight into the feedstocks that they are already familiar with. However, due to the wide scope of feedstocks covered, it is also important to note that the book has been well proof-read and the writing style is clear throughout. The points made are easy to understand, even if, as previously stated, some less-experienced readers may need to do some background reading on some of the technical aspects first.

Due to the interdisciplinary nature of food waste valorisation, several techniques are covered multiple times across different chapters. For readers going through from start to finish this may appear somewhat repetitive, however each time a technique is covered, the details are provided in context to the relevant feedstock. For readers focusing on chapters specific to their feedstocks, this approach is also useful to provide instant clarity and to avoid having to ‘back and forth’ between chapters.

Overall, the book is well written and provides very comprehensive and in-depth coverage of a broad field. Whilst it may be let down by inconsistency between chapters, it is important to note that some of this is necessitated by the varying levels of attention different feedstocks have received to date. It is therefore likely to be a useful reference point either for newcomers to the field to get started or to provide useful insights to more established readers perhaps looking to expand their knowledge of the field to more unfamiliar feedstocks.
The making of juice

This is the latest volume in the IFST Advances in Food Science Book series, concerning the application of novel processing technologies in the manufacture of non-alcoholic beverages. Intended as a reference work summarising the latest food science research and practice, and featuring contributions by recognised international experts, the book is divided into three sections: Juice Processing, Non-Alcoholic Beverages and Waste in the Juice and Non-Alcoholic Beverage Sector.

Part one has chapters on pome fruit juices, citrus fruit juices, Prunus fruit juices, vegetable juices, exotic fruit juices, berry juices and juice blends. Each chapter begins with a section summarising the conventional processing techniques and their effects on microbiological quality and nutritional and organoleptic attributes.

This is then followed by a review of the novel processing techniques. These are subdivided into thermal (such as ohmic heating) and non-thermal methods (such as high-pressure processing), with corresponding data on the effects on microbial, nutritional and organoleptic quality of the various processes. The chapter ends with a brief section on conclusions and future trends. This format gives the book a consistent feel, which is useful for quick reference purposes, though it does lead to a good deal of repetition, in that the conventional techniques generally involve thermal processing and the effects on microbial, nutritional and organoleptic quality are essentially similar.

Part two, dealing with non-alcoholic beverages, covers grain-based drinks (soy, rice and oat), soups and functional beverages. These chapters are organised along the same lines as those in part one, though there is more background information given for each sector. This reflects the greater complexity of the types of products covered, with more processes, including fermentation and a wider range of ingredients. Again, a good overview of these areas is provided and current practice is contrasted with the most promising approaches using new technologies.

The final section, part three, deals with waste and by-product utilisation in the beverage industry. This is the shortest of the three sections and consists mainly of a review of current methods for using by-products from the various types of processed fruit and vegetables. There is little discussion of novel technologies, which are restricted to pulsed electric field and ultrasonication as methods of breaking down plant materials as an aid to extraction of bioactive compounds. There is little discussion of processing and the effects on microbial, nutritional and organoleptic quality.

Overall, this is a well-written and presented review of the current state of innovation in beverage processing and would be a valuable resource for anyone researching the subject from an academic perspective or as an introduction for more practical, production-based readers.

Being a member of IFST provides you with a whole range of benefits to support your professional development. But, more than this, you’re part of a professional network which is working tirelessly to:

**SETTING AND RECOGNISING PROFESSIONAL STANDARDS**

The food and drink sector demands high levels of expertise and professionalism to ensure that our food is always of the highest possible standard. Our professional registers are widely recognised and valued throughout the sector as the benchmark for skills and expertise for food professionals.

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As a charity and professional body that is independent of government, industry and any other organisation, IFST is in a prime position to provide impartial, science-based information.

**PROVIDING AN ACCESSIBLE KNOWLEDGE BASE**

Scientific knowledge is fundamental to everything IFST delivers. We encourage the exchange of knowledge amongst food professionals. This knowledge needs to be evidence-based, yet understandable and accessible.

**SUPPORTING THE FUTURE OF FOOD**

The shortage of new talent to fill skilled roles in the food sector is a critical issue. A key focus for the Institute is therefore encouraging and supporting the future generation of food scientists and technologists. We have developed, often in collaboration with others, a wide range of activities and events.
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<table>
<thead>
<tr>
<th>Acrylamide &amp; Furan</th>
<th>Mycotoxins</th>
<th>Foreign Body Investigations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nutrition</td>
<td>Vitamins</td>
<td>Contaminants</td>
</tr>
<tr>
<td>Allergens</td>
<td>Taints</td>
<td>Additives &amp; Preservatives</td>
</tr>
<tr>
<td>Microbiology Challenge Testing</td>
<td>GMO</td>
<td>Metals &amp; Minerals</td>
</tr>
<tr>
<td>Illegal Dyes</td>
<td>Shelf Life</td>
<td>3MCPD &amp; Glycidyl Esters</td>
</tr>
<tr>
<td>Food Authenticity</td>
<td>Food Safety</td>
<td>Food Composition</td>
</tr>
</tbody>
</table>

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