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All change

Nothing stands still for long within the global food sector.

ANNA LAMBERT
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INNOVATION IS KEY to success within our world, with food consumers hungry for new experiences, albeit within the boundaries of safety, sustainability and, increasingly, ethical traceability. We take a look at some of the latest developments within this edition of *New Food*.

Issues driving the phenomenal growth of the plant-based food sector include a need to protect the planet and avoid animal cruelty. One company that believes it is meeting both these goals – and plenty more besides – is SENS, which is rearing hundreds of thousands of crickets to turn into protein-rich flour in its factory in Thailand. Company founder Radek Hušek charts the business's journey to market on page 38.

Health issues are another factor driving today's consumer and Denis Lynn of Finnebrough in Northern Ireland is acutely aware of concerns regarding the links between processed meat and cancer. On page 10, we look at his quest to produce nitrate-free bacon.

Sometimes change isn't about new product development, it's about a change of attitude. In the summer of 2018, over two thousand laboratory-confirmed cases of cyclosporiasis in the US were reported to the Centers for Disease Control and Prevention, with at least 160 people hospitalised. Yet, despite the devastation they can cause, research into such parasites and how to stop them remains a neglected area, says Professor Lucy Robertson, Chair of a European Cooperation on Science and Technology Action on foodborne parasites. Read her analysis on page 28.

We have more analysis in our features on the facts, myths and perceptions surrounding natural ingredients (page 52), the need for a circular food chain (page 48) and the power of cinnamon (page 58). Meanwhile, the hot topic of food fraud and its implications for businesses is examined via Tomi Helin's cover story on page 42, exploring the difference between bilberries and blueberries. Further articles looking at meat (including a timely Q&A with 2 Sisters Food Group's Helen Sisson), food safety and processing within our In-Depth Focus sections complete the picture. Plus we have key event dates within the global food diary and round-ups of our latest webinars to explore.

Finally, it's all change for me, too, as I say goodbye to *New Food* with this issue. I've really enjoyed covering your stories over the past year – thank you so much for sharing them with us. In the immediate future, the highly experienced Craig Waters will be your new editor. I know he will welcome your research and case studies, so do get in touch with him if you have stories to share at cwaters@russellpublishing.com.

Want to be published in **New Food**?

New Food is looking for authors for 2019. If you are from a food manufacturer, university association or research institute and are interested in submitting an article on processing, food safety, ingredients, NPD, analysis or sustainability, please send a synopsis to: alambert@russellpublishing.com

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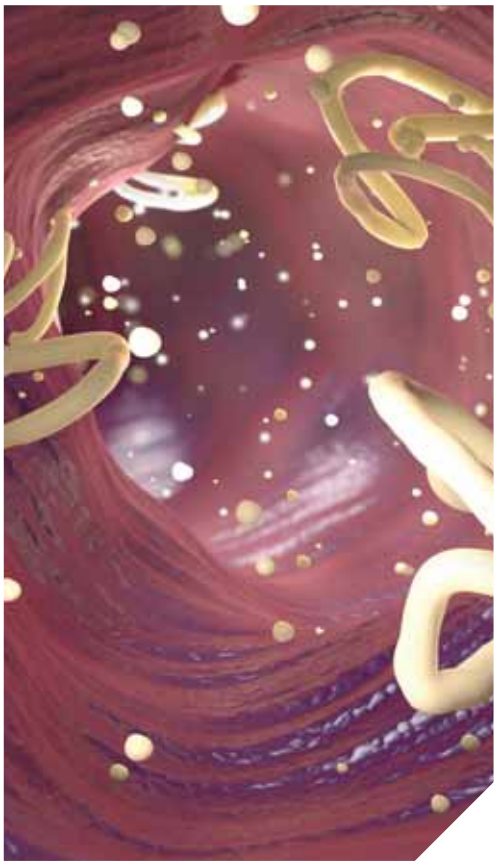

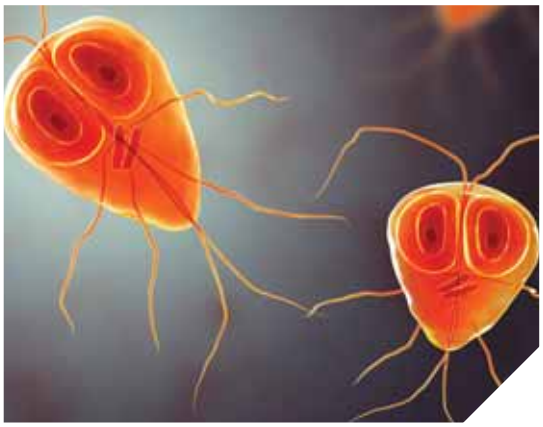

NEW FOOD LEADERS' SERIES 2019

Labour Supply – The New World Post Brexit

Gillian Haythornthwaite of the Association of Labour Providers assesses the working environment post Brexit and beyond

AS WE GO to press, there is still much confusion surrounding Brexit, but there are some aspects we do know about. The immigration white paper published on 19 December 2018 provided us with details of the post-Brexit world. Some of the key points are:

- EU and Non-EU migrants will be subject to the same immigration rules.
- The focus will be on high- and medium-skilled workers coming to work in the UK with no cap on numbers.
- No permanent route for low-skilled workers, with the exception of edible horticulture. The UK Government is running a small pilot seasonal workers scheme in 2019/20, which it is hoped will become the seasonal workers route into the UK post Brexit.
- Temporary short-term visas will be introduced and reviewed by 2025, allowing workers from low-risk countries to come to the UK to work for 12 months and then return home for a 12-month cooling-off period.

The immigration policy is based on confirmation of a Brexit withdrawal agreement. During the transition period, EU workers can continue to come and work in the UK. EU citizens will also have the right to apply to the EU Settlement Scheme for settled or pre-settled status if they have lived in the UK for a minimum of six months in the last 12 months, enabling them to continue to live and work in the UK post Brexit.

In terms of labour supply in a No Deal situation, there will be different arrangements for EU Citizens. Only those who were resident prior to the Brexit date will be eligible to apply to the EU Settlement Scheme. EU Citizens will still be able to come and work in the UK via the European Temporary Leave to Remain for three months without a visa. If they wish to remain for longer, they will need to apply for an extension to stay for up 36 months and pay an application fee.

If we look forward to January 2021 and the implementation of the new immigration policy, there will be some key points that businesses and individuals will need to be aware of:

- The routes to come and work in the UK will be much more regulated and controlled.
- The Government has invested in a new electronic system to manage this process, which will link to the e-gates at our borders
- The focus will be on high and medium skilled immigration.
- There will be routes for low skilled workers to come and work here, whether this is the seasonal workers scheme, the temporary short-term visa or the European leave to remain, but they may not be permanent routes.
- Right to work checks for non-UK citizens will be through the digital checking service. This will enable employers to check both right to work and settled or pre-settled status providing the necessary Statutory Excuse.

The impact of today's labour shortages means workers can choose which job they want to do, and if they don't like one job there is always another. New technologies are being developed to reduce the reliance on low-skilled workers. It is becoming easier to justify this type of investment cost.

Employers need to focus on improving retention at all levels. This will be even more important in 2021, when the new immigration rules come into effect. Meanwhile, the UK needs the rest of the world to see that it remains 'open for business' and that it is working to achieve a fair and managed immigration system that enables businesses to access the skills that they need.

GILLIAN HAYTHORNTHWAITE is the Head of Policy for the Association of Labour Providers (ALP). The ALP represents and supports members to ensure that the provision, use and management of labour in the consumer goods supply chain across food processing, horticulture and wider manufacturing, industrial, warehousing and distribution sectors is recognised as a model of good practice.

"Temporary short-term visas will be introduced and reviewed by 2025, allowing workers from low-risk countries to come to the UK to work for 12 months and then return home for a 12-month cooling-off period"

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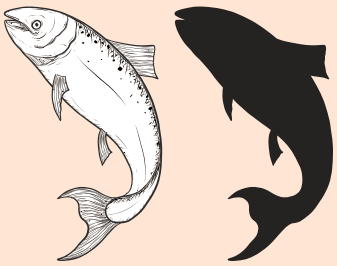
ROUND UP

The editor's pick of the most interesting developments within the food and beverage industry



FDA lifts import alert on GE salmon

GENETICS

THE US Food and Drug Administration (FDA) has deactivated a 2016 import alert that prevented genetically engineered (GE) AquAdvantage Salmon from entering the US. This follows comprehensive analysis of the scientific evidence, which determined that the GE Atlantic salmon met the statutory requirements for safety and effectiveness under the Federal Food, Drug, and Cosmetic Act.

The deactivation of the import alert means that AquAdvantage Salmon eggs can now be imported to the company's contained grow-out facility in Indiana to be raised into salmon for food. Says the FDA, "As was determined during the FDA's 2015 review, this fish is safe to eat, the genetic construct added to the fish's genome is safe for the animal, and the manufacturer's claim that it reaches a growth marker important to the aquaculture industry more rapidly than its non-GE farm-raised Atlantic salmon counterpart is confirmed."

Additionally, as part of its approval, the FDA also analysed the potential environmental impact that an approval of the AquAdvantage Salmon application would have on the US environment and published its final Environmental Assessment and Finding of No Significant Impact in November 2015. Based on the multiple forms of physical and biological environmental containment measures proposed by the company in its application, the FDA found that an approval of AquAdvantage Salmon's application would not cause significant environmental impact.

Gut microbiome helps body against food allergies

NUTRITION

RESEARCHERS at the University of Chicago have found that gut microbes from healthy human infant donors transplanted into mice protected animals exposed to milk from experiencing allergic reactions. Gut microbes transplanted from infants allergic to milk, on the other hand, did not.

"To better understand how commensal bacteria regulate food allergy in humans, we colonised germ-free mice with faeces from healthy or cow's-milk-allergic (CMA) infants," the researchers wrote. "We found that germ-free mice colonised with bacteria from healthy, but not CMA, infants were protected against anaphylactic responses to a cow's milk allergen. Differences in bacterial composition separated the healthy and CMA populations in both the human donors and the colonised mice."

Previously, scientists have identified that infants allergic to cow's milk had different compositions of gut microbes to those of non-allergic infants. Research has also shown that some microbes are associated with a lower risk of developing a food allergy.

The research team also analysed the microbes in samples of the infants' faeces, and found numerous differences in the stools of infants with and those without allergies to milk.

"Our findings demonstrate that intestinal bacteria are critical for regulating allergic responses to dietary antigens and suggest that interventions that modulate bacterial communities may be therapeutically relevant for food allergy," the University of Chicago researchers wrote.

The findings of the study were published in the journal *Nature Medicine*.

Singapore to ban PHOs

HEALTH

SINGAPORE is to join the US, Canada, and Thailand in banning partially hydrogenated oils (PHOs), Senior Parliamentary Secretary for Health, Amrin Amin, announced in March.

In May 2018, the World Health Organization (WHO) released REPLACE, a step-by-step guide for the elimination of industrially-produced trans-fatty acids from the global food supply chain, which it hopes to see achieved by 2023. PHOs found in foods including margarine, crisps and fast-food kebabs are a major source of such acids. WHO estimates that every year, trans-fat intake leads to more than 500,000 deaths of people from cardiovascular disease. PHOs can be replaced with more healthy options such as unsaturated sunflower oil.

Although Singapore's food manufacturers are already required by law to declare and limit the amount of trans fat in cooking oil and fats, resulting in local trans-fat intake reducing by half from about two grams per day in 2010 to one gram per day in 2018, Mr Amrin said it was, "...timely to build on this,"

In October 2018, the European Commission (EC) asked food manufacturers and retailers to comment on a proposal to limit the amount of artificial trans fats in foods sold in the EU to a maximum of 2g per 100g of fat.

Fears over US chlorinated chicken in UK post-Brexit re-examined

FOOD SAFETY

ROBERT WOOD 'Woody' Johnson, The US ambassador to Britain, re-fired the debate surrounding the possibility and implications of US chlorinated chicken hitting the UK market post-Brexit. In an article for *The Telegraph* newspaper in March. He claimed that the chlorination process used didn't differ from that used by European farmers to treat fruit and vegetables. "Inflammatory and misleading terms like 'chlorinated chicken' and 'hormone beef' are deployed to cast American farming in the worst possible light...It is time the myths are called out for what they really are. A smear campaign from people with their own protectionist agenda."

As BBC online explained, "Washing chicken in chlorine and other disinfectants to remove harmful bacteria was a practice banned by the European Union (EU) in 1997 over food safety concerns. The ban has stopped virtually all imports of US chicken meat which is generally treated by this process. It's not consuming chlorine itself that the EU is worried about – in fact in 2005 the European Food Safety Authority said that, "exposure to chlorite residues arising from treated poultry carcasses would be of no safety concern."

Chlorine-rinsed bagged salads are common in the UK and other countries in the EU. But the EU believes that relying on a chlorine rinse at the end of the meat production process could be a way of compensating for poor hygiene standards – such as dirty or crowded abattoirs."

If restrictions were dropped regarding US meat and poultry in the UK post-Brexit, the fear is that food safety would suffer accordingly.

A Downing Street spokeswoman was quoted in *The Guardian* newspaper as saying, "We have always been very clear that we will not lower our food standards as part of a future trading agreement."

Food Price Index up

FOOD SECURITY

GLOBAL food prices rose in February, with the FAO Food Price Index averaging 167.5 points, up 1.7 percent from January, in part driven up by sharp increases in dairy prices.

The Index, which is an indicator of the monthly changes in international prices of a basket of food commodities, is currently at its highest level since August 2018, but still nearly 2.3 percent below its value at the same month last year.

The FAO Cereal Price Index averaged almost 169 points in February, up marginally from January, mostly on firmer maize prices.

The FAO Vegetable Oil Price Index increased by 1.8 percent, to 133.5 points, marking its highest level since October 2018. The rise in February was mainly due to higher price quotations of palm, soy and sunflower oils.

The FAO Meat Price Index was up slightly, supported by higher prices of bovine and pig meat.

The FAO Dairy Price Index increased by 5.6 percent from January, driven by a strong import demand for Skim Milk Powder, Whole Milk Powder and cheese. An expected seasonal drop in butter production also contributed to pushing up butter prices.

The FAO Sugar Price Index rose by 1.2 percent from January, largely on concerns over production prospects in some of the main producing countries.

FAO and GAIN team up to offer more nutritious food for all

NUTRITION

THE FOOD and Agricultural Organization of The United Nations (FAO) and the Global Alliance for Improved Nutrition (GAIN) have agreed to join forces to increase the availability and affordability of nutritious food for all in developing countries.

The partnership aims to enable inclusive and efficient agricultural and food systems, focusing on new approaches that engage small and medium enterprises (SMEs) to promote market-based solutions as a key tool for improved nutrition.

FAO and GAIN say they also plan to make urban food systems more nutrition-sensitive, by supporting GAIN's Urban Governance for Nutrition Program and FAO's Urban Food Agenda.

At present, more than 50 percent of the world's population lives in urban areas, and this figure is expected to rise to 70 percent by 2050. Food and nutrition security of poor urban populations remains at risk as a consequence of the volatility and rapid increases in food prices, natural disasters and climate change effects, points out the FAO.

Said FAO Director-General, José Graziano da Silva, "We must focus more attention on the promotion of healthy diets, especially now with the epidemics of obesity and overweight. We know the main causes of hunger and how to defeat it." However, he noted that there is still a need for greater monitoring and regulation in order to make food systems safer and more resilient.

Lawrence Haddad, Executive Director of GAIN, commented. "We will focus on practical ways we can jointly help businesses and city governments deliver nutritious diets."

The safety and integrity of rice production

On 5 March, Chris Elliott, Professor of Food Safety and Founder of the Institute for Global Food Security, Queen's University Belfast, offered participants fascinating insight regarding the safety and integrity of rice production, through a webinar sponsored by Agilent.

RICE IS A hugely important topic, simply because so many people across the world rely on it as their main source of food. Many of the questions that followed Chris's presentation centred on contamination and fraud. He also looked at how arsenic gets into rice – a factor that's based on the amount present in the soil and water in any particular rice-growing region. That arsenic can come either from natural sources or via man-made pollution. While arsenic in rice is a major public health concern, it is not directly linked to fraud. Comments Chris, "As regulations across the world grow increasingly strict regarding permissible levels of arsenic in rice, there will be an opportunity for fraudsters to pass off rice grown in high arsenic areas for that grown in low arsenic areas. Arsenic monitoring may therefore be required, to check such fraud isn't occurring.

"The detection of rice fraud is about having good knowledge of supply chains and rigorous audits in place but it's also about using science, as I outlined in the webinar. The determination of geographic origin of rice will be based on various types of mass spectrometric analysis, elemental and isotopic. A combination of both data sets makes it a much more reliable and powerful way to identify where the rice was grown. I also think metabolomics will play an increasingly large role in future in terms of identifying where rice was grown. Different molecular platforms PCR and NGS will also have their place in determining the variety of rice, eg. is it truly basmati? I'm a strong advocate of using various types of molecular spectroscopic platforms to gain a lot of important information about the variety, quality and potentially origin of rice. The ability to undertake low cost and potable analysis on some platforms is a major research theme of ours within the Institute for Global Food Security. I hope I can present a lot more scientific data on the various ways to detect fraud in rice in a future webinar."

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MEAT

Denis Lynn of Finnebrough charts his career trajectory and explains why he's so passionate about his latest venture.

David Lindars of The British Meat Processors Association examines the scientific research that could revolutionise the UK's 10-Day rule on shelf life.

Helen Sisson, Technical Director of 2 Sisters Group, looks to the company's future.

Making the dream a reality

From selling a new type of chip to raising the bar in venison farming and pinning down the formula for nitrite-free bacon, *Denis Lynn* of Finnebrogue Artisan has always aimed to do things differently. Here, he charts his trajectory through the food sector and explains why he feels so passionately about his latest venture.

BACON IS A British institution. Ham is eaten and loved the world over. But these delicious processed meats come with a significant risk to our health. Nitrites are used to cure the meat, to keep it pink and to preserve it so it can stay on the supermarket shelves for longer. However, when nitrite-cured meat is cooked and ingested, it produces carcinogenic nitrosamines in the stomach. In 2015, a major report from the World Health Organization linked 34,000 worldwide cases of colorectal cancer a year to diets high in processed meats[1] – a report that prompted me, a sausage maker from Northern Ireland, to seek out a solution.

How it all started

My career in the food sector began back in 1985 with Lynn's Country Foods. I started the company not because I had any desire to work for myself, or because it was business that I had always dreamed of working in. My reasons were less romantic: I had no job and a mortgage, and I didn't want to sign on at the local dole office. So, with the help of the bank, I bought a second-hand car and began buying pizzas and pies from a small manufacturer in Comber, Northern Ireland and selling them to shops and restaurants. I worked hard and within a few months I bought a little white van (not refrigerated, but at least it was white) and had hired my first employee.

I eventually worked out that the best type of business to be in was one where I could maximise both volume and margin at the same time. These two things don't typically go hand in hand, particularly in a low margin area such as food. I believed that the only way to achieve this was through making a better product than anything else that was available. Things really took off when I discovered a new type of French fry: Lord Chips.

> *"I eventually worked out that the best type of business to be in was one where I could maximise both volume and margin at the same time"*

Partially cooked in the factory and then chilled at 2°C, they cooked in 90 seconds in the restaurant – far more quickly than frozen – but they tasted like fresh chips and weren't hollow like the frozen variety. We quickly became Lord's largest customer in Europe and got the agency for the whole of Ireland.

Love at first sight

Having made some money through chips and distribution I bought the stunning Finnebrogue Estate in Downpatrick, Northern Ireland in 1991 – I just fell in love with the land. In 1993, I sold the distribution and chip side of the business to O'Kanes Poultry, having decided to retire from business and try my hand at beef farming. Once I'd figured out how to farm beef cattle, I became concerned at the level of subsidies being paid to farmers by the EU and felt that I would rather be in a real-market situation and a controller of my own destiny. So, in 1996, we sold every single cow, fenced the entire estate and overnight became the largest deer farm in the UK and Ireland. I was also listening to friends, family and the general public struggling to come to terms with the impact of BSE and saw an opportunity to provide healthier meat. Finnebrough Artisan was born.

Point of difference

I began selling to top end restaurants around Ireland at first. As ever, it was important for me to offer something different and superior to anything else available. The restaurant trade was full of poor quality and inconsistent wild venison and there was a real opportunity for something that gave more chefs more confidence that the quality would consistent. On a personal level, I believe that animals deserve as good a life as possible and that, as a farmer, it is my responsibility to make sure this happens – and to communicate it's happened to our customers. I then began by looking at factors that influence meat quality and it became clear that the age of the animal and control of stress would be critical to delivering a consistently great product. Once I had these things sorted, the product was quickly snapped up by retailers and restaurant owners, from Marks and Spencer and Raymond Blanc to Gordon Ramsay and Heston Blumenthal.

To make sure I could deliver this quality consistently, repeatedly and at a scale, we custom-built a processing plant to supply M&S. Once this model proved successful, we set out to do the same for sausages, burgers, stuffings and other products. Today I believe our pork sausages are the finest anywhere in the UK, delivering unbeatable growth in Marks and Spencer and to the Asda Extra Special ranges that we supply. Our wagyu beef, vegetarian and other food products are all of the highest quality, produced in one of our three state-of-the-art factories in County Down, which includes the £25 million food processing plant opened on the Finnebrogue estate back in 2016. Our commitment to quality has been the cornerstone of our phenomenal growth from just a £5m turnover in 2009 into a £100m family-owned food business today, employing over 500 people.

In making sausages for many of the UK's major supermarkets, it always made sense for us to make bacon and ham as well. But I refused to make a single rasher or slice until we could find a way to do it without nitrites. I was not going to add chemicals that had been linked to cancer to any food that I produced. My team travelled the world looking for an alternative to nitrite. For years, we were sent up blind alleys, wooed by people claiming to have an answer to the nitrites conundrum, only to later find that, for instance, they were simply adding celery juice or other natural sources of nitrites to their meat to cure it. The science says that, whatever the source of nitrite – whether from sodium nitrite (salt), potassium nitrite (salt peter) or nitrites derived from vegetable extracts – it will still produce nitrosamines when cooked and ingested and still increase the risk of cancer. Indeed, using vegetable-extract nitrites to cure meat is even banned under EU law.

Finally, after many years of searching, we came across Spanish chemist, Juan de Dios Hernandez. As chief executive of ingredients solutions company Prosur, he has made it his life's work to take artificial additives out of food and replace them with safe, natural alternatives. Through his work he had come across a blend of Mediterranean fruit and spice extracts that turned pork pink – traditionally recognised as a sure sign of nitrite contamination. But on closer inspection there were no nitrites to be found – just natural whole fruit extracts, high in antioxidants, which have all the positive effects of nitrites, but without the carcinogenic risk. We launched the first mass-produced nitrite-free bacon brand in the UK using this ground breaking technology – opening a £17million factory dedicated to its production earlier this year – and it has been a phenomenal success.

> *"There is a huge demand for additive-free food and, as the salience of the nitrites issue rises, demand for these safer alternatives rises, too"*

BELOW: The company invested £17million in a state-of-the-art production facility, which opened earlier this year

ABOUT THE AUTHOR

DENIS LYNN is Chairman of Finnebrogue Artisan, a company he founded in 1985. Today employing 470 people and with an annual turnover of £75 million, Finnebrogue has made its name as a leading supplier of top-tier sausages, bacon and venison.

In the 15 months since our launch, Naked Bacon has established itself as the second biggest bacon brand in the country – annualising £15m in retail sales. It has provided consumers with a safer nitrite-free and readily available alternative for the first time – and it has brought tens of thousands of people back to eating bacon who had previously given it up because of the nitrites risk. There is ahuge demand for additive-free food and, as the salience of the nitrites issue rises, demand for these safer alternatives rises, too.

It isn't just the World Health Organization that has pointed to the risks. Decades' worth of research has demonstrated why nitrites should not be added to meat. As far back as the 1970s, for instance, Dr William Lijinsky, a biochemist and laboratory director at the National Cancer Institute in the US, said studies with rats provided overwhelming and compelling evidence that nitrosamines were carcinogenic for humans.[2]

The wealth of available evidence has prompted some significant action in the first quarter of 2019. A coalition of cross-party politicians joined leading food scientists and medical professionals in calling on the food industry to remove nitrites from processed meats – and pressuring government to intervene if no action is taken.[3] This group was led by Professor Chris Elliott, chair of the Institute of Global Food Security at Queen's University in Belfast and the scientist who led the investigation into the horse meat scandal in 2013. Other signatories included the deputy leader of the Labour Party, Tom Watson MP, two former shadow environment secretaries, a Conservative MP and MEP, a Liberal Democrat peer and a leading NHS and Harley Street cardiologist.

The next step

The question for policy makers, my colleagues in the food industry and for me is, what now?

My answer is clear. I want to remove nitrites from all processed meats in the UK within the next three years – and I am willing to share our technology to achieve this ultimate goal. My priority is not to become Britain's biggest bacon manufacturer, but simply to rid these needless chemicals from our processed meats and to cut the cancer risk from those Sunday morning fry-ups so many of us love.

Nitrites are no longer needed to flavour our bacon, to preserve our bacon or to keep it pink, so why would we use them? The food industry must decide what it wants to do.

My hope is that the UK processed meat industry will seize the golden opportunity that preservation without nitrates offers to lower the rates of bowel cancer in the UK, reduce the strain on our National Health Service and prove that we produce some of the finest, safest food anywhere in the world. We have the chance to be on the right side of history – and to deliver a huge success story for the British food industry that would prompt our friends around the world to also make this positive change. I am clear in my mind that if we do not act, history will not look kindly on us – and consumer pressure will eventually force the Government to intervene instead.

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EXPERTVIEW

Philip Ansell
Marketing Manager,
UCRETE Industrial Flooring

"Environments inside meat processing factories are changing: cryogenic processes are on the increase, and advanced automation requiring different types of floors are inevitable"

Think about floors: your future may depend on them

Bigger factories, tighter regulation and modern technology mean meat-industry floors need to work harder than ever.

STRANGE THINGS, floors; you never pay them any attention them until they trip you up, and it's the same with floors in the meat industry. What return on investment is your flooring making? That's a hard thing to calculate – until your floor fails you and your business, threatening hygiene, food quality, worker safety and your reputation. Then the cost of a poor floor is all too clear.

The role of floor finishes in the meat industry is changing; 40 years ago it was enough that it protected the substrate from the fats, food acids and cleaning regimes that erode concrete. Then, providing a hygienic, easy-to-clean floor became critical. It still is. In the 1990s, slip resistance was added to the list of requirements. These are not mutually exclusive, of course; floors with R13 slip resistance to DIN 51130 and which have a bacterial cleanability that's equal to that of stainless steel are available.

But what of the future? Environments inside meat processing factories are changing: cryogenic processes are on the increase, and advanced automation requiring different types of floors are inevitable. Factories to accommodate these needs are being built now, and floors to meet the future are also available. They are resistant to cryogenic spillages as well as to high temperature thermal shock, and with the electrical properties required for our automated future.

Floors that don't meet todays rigorous standards are not only inefficient and unhygienic, they're unsustainable, too. It seems crazy to me that floors are still being sold into the meat industry that will only last a few years, or that require continuous ongoing repairs, when we have systems available that will still be in service after decades. A durable floor saves money, improves productivity and protects your investment.

Make the right choice in flooring and you won't have to give it another thought; it won't trip you up, and it will be ready for your future.


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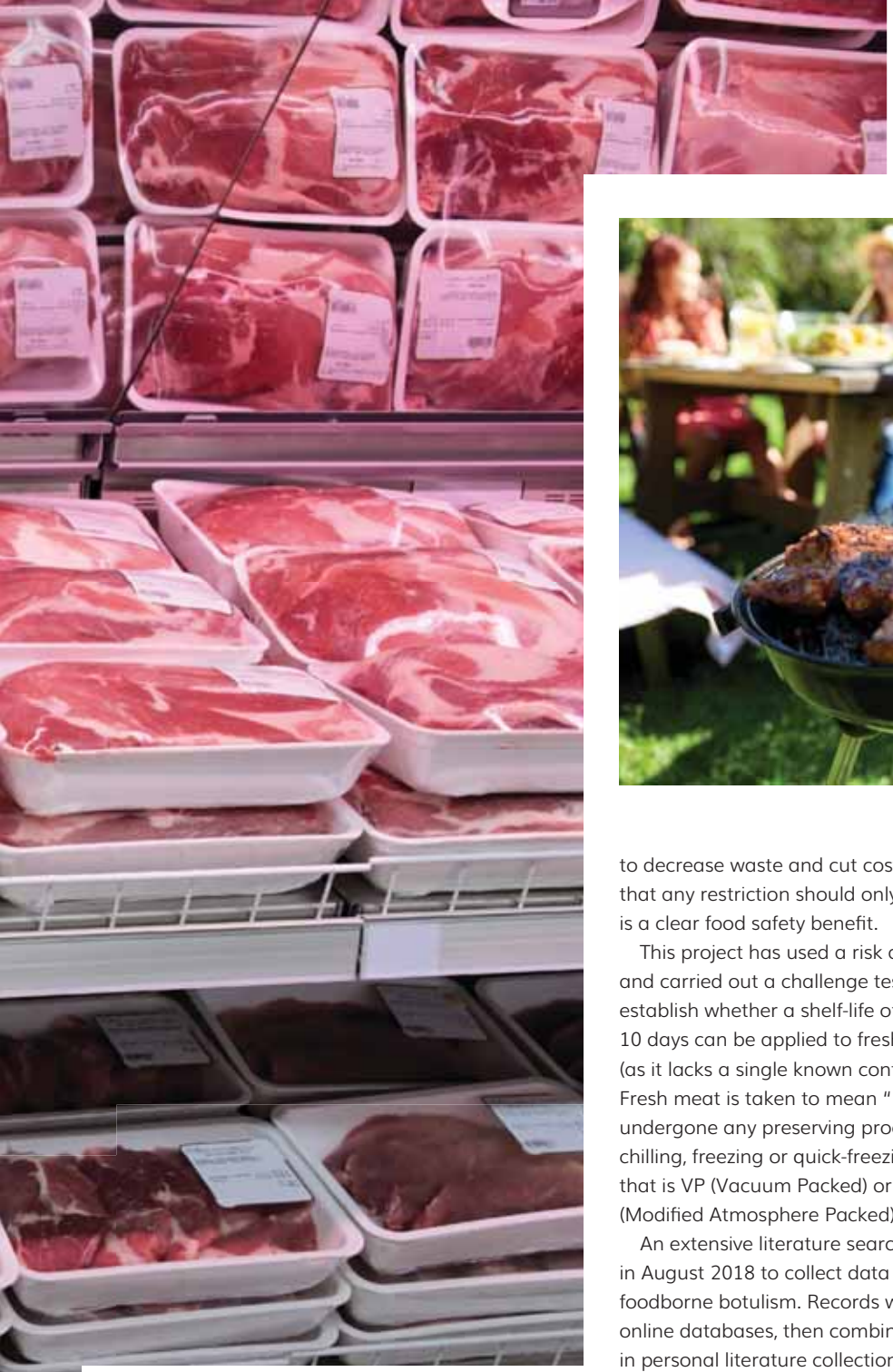
Time to rethink the **shelf-life rule?**

Over the last year, the British Meat Processors Association together with Meat and Livestock Australia have jointly funded a project to provide independent research into whether a retail shelf-life of greater than 10 days can be applied to fresh chilled meat. *David Lindars* of the BMPA assesses the results.



THE UK Food Standards Agency Vacuum Packed/Modified Atmosphere Packed (VP/MAP) Guidance (FSA, 2017) currently restricts the shelf-life of VP/MAP foods (including fresh meat) held at 3°C to 8°C to 10 days, unless suitable grounds for a longer shelf-life can be identified. Given the severity of botulism, a precautionary approach is understandable, yet fresh meat has a particularly strong safety record globally, despite no other countries providing similar guidance.

The results of this study have just been published and they suggest that retail shelf life could be extended beyond the current recommended 10-day shelf life limit for VP/MAP fresh meat. This is important news for British meat processors as it potentially removes a significant technical barrier to trade as well as offering the opportunity to decrease waste and cut costs. It also suggests that any restriction should only be applied if there is a clear food safety benefit.

This project has used a risk assessment approach and carried out a challenge test experiment to establish whether a shelf-life of greater than 10 days can be applied to fresh chilled meat (as it lacks a single known controlling factor). Fresh meat is taken to mean "meat that has not undergone any preserving process other than chilling, freezing or quick-freezing, including meat that is VP (Vacuum Packed) or MAP wrapped (Modified Atmosphere Packed)" (Peck, 2019).

An extensive literature search was carried out in August 2018 to collect data on outbreaks of foodborne botulism. Records were retrieved from online databases, then combined with articles held in personal literature collections and references cited in or citing eligible articles. Searches were not restricted by country or language. The search of the literature failed to uncover any cases of botulism associated with fresh chilled VP or MAP meat. Of the 196 references initially identified as potentially suitable to be included in the database, 14 were considered eligible as the outbreak vehicle fitted the criterion of a commercial food intended to be stored chilled.

To put that into context, it is estimated that in the UK over the period 1999 to 2017, excluding 2006, the total number of 250g portions of beef, pork and lamb consumed was over 31 billion, 22 billion and 8.6 billion respectively: a total of 62 billion 250g portions.

Using Food & Agriculture Organization (FAO) data, the number of portions of beef, pork and lamb consumed globally in 2015 totalled 820 billion 250g portions. And, in 2017 OECD consumption ›

ABOVE: According to FAO data, the number of portions of beef, pork and lamb consumed globally in 2015 totalled 820 billion 250g portions

> *"The results from the new challenge test experiment both support a shelf-life of greater than 10 days for fresh chilled beef, lamb and pork held at 3 °C to 8 °C"*

ABOVE: Current practice provides a high level of protection with respect to non-proteolytic Clostridium botulinum

data indicates that a total of 620 billion portions were consumed. Both datasets demonstrate significant global consumption of fresh beef, pork and lamb each year.

Following the release of the FSA 2017 guidance, an industry consortium was formed to commission and jointly fund the research project, made up of meat processors and retailers, most of whom are members of the British Meat Processors Association and Meat & Livestock Australia.

Aims and Objectives

The primary aim of the work is to provide information to assist industry in dealing with queries from enforcers and customers in relation to the FSA guidance. This aim is achieved through the writing of a document that sets out industry practice in relation to fresh meat distributed and/or sold to the final consumer and clearly establishes the level of protection with respect to non-proteolytic *Clostridium botulinum*. Work involved the collection of existing information for a risk assessment to assure safety with respect to non-proteolytic *C. botulinum*.

The key objective of the project is to prepare a risk assessment setting out the level of protection, with respect to non-proteolytic *Clostridium botulinum* and foodborne botulism, when employing current industry practice regarding VP/MAP fresh meat for certain meat species distributed and/or sold to the final consumer (that do not contain known controlling factors). This risk assessment includes and takes account of:

1. hazard characterisation
2. specified meat species and product types
3. industry practice
4. exposure assessment (market/sales data)
5. exposure assessment (spore loading)
6. foodborne botulism incidents related to fresh meat
7. data on growth/neurotoxin formation by *C. botulinum* in fresh meat.

RIGHT: longer shelf lives could mean less wastage

ABOUT THE AUTHOR

DAVID LINDARS is technical operations director at BMPA. He brings many years of experience in food retailing, hotels & hospitality and food manufacturing to the organisation.

The report incorporates knowledge and expertise with non-proteolytic *C. botulinum* and in microbiological food safety, importantly including previous FSA and AHDB-funded work. It is hoped that wide dissemination of the findings will assist industry in dealing with queries from enforcers and customers in relation to the FSA 2017 guidance (FSA, 2017).

Report Findings

The ability not to be constrained by a 10-day shelf-life, as indicated in present FSA guidelines (2017), and the freedom to adopt a shelf-life greater than 10 days at 3°C to 8°C for fresh chilled beef, lamb and pork could bring significant economic, social and sustainability benefits to producers, processors and retailers. Such freedom removes a technical barrier to trade. There may also be environmental and consumer benefits through lower food wastage.

There is no evidence that currently-applied UK shelf lives combined with current production standards are unsafe. If changes are made to industry practice, then these may affect the level of protection.

Some previous challenge test studies are subject to various limitations, however a new challenge test study carried out in the current project demonstrated that samples of beef and lamb inoculated with spores of non-proteolytic *C. botulinum* and incubated at 8°C did not become toxic to day 50 (beef) or day 35 (lamb) (i.e. <40 pg type B toxin g-1 of meat and <40 pg type E toxin g-1 of meat). All samples of pork were negative for type B and type E neurotoxin (i.e. <40 pg type B toxin g-1 of meat and <40 pg type E toxin g-1 of meat) at day 25, with one sample positive for type B neurotoxin at day 35 (i.e. >40 pg type B toxin g-1 of meat). The positive pork sample had spoiled by day 12.

Data provided by industry members of the project consortium indicates that UK industry applies a maximum chilled retail pack shelf life at 3°C to 8°C of up to 23 days for beef, 27 days for lamb, and 18 days for pork. Using a risk assessment approach, it was established that the current industry practice provides a high level of protection with respect to non-proteolytic *Clostridium botulinum*, estimated as >10.8 safety units (decimal number of products (i.e. $>10^{10.8}$) marketed per number causing botulism).

The estimation of the level of protection and the results from the new challenge test experiment both support a shelf-life of greater than 10 days

> ***"There is no evidence that currently-applied UK shelf lives combined with current production standards are unsafe."***

> *"There is no evidence that currently-applied shelf lives of fresh chilled beef, pork and lamb combined with current production standards are unsafe"*

for fresh chilled beef, lamb and pork held at 3°C to 8°C and supports currently-applied UK shelf lives combined with current production standards.

Conclusions and recommendations

Currently, the UK industry typically applies a chilled retail shelf life at 3°C to 8°C of up to 11-13 days to packs of fresh beef, pork and lamb, with a maximum of 23 days for beef, 27 days for lamb, and 18 days for pork. This practice provides a high level of protection with respect to *C. botulinum*.

The estimation of the level of protection and the results from the challenge test experiment both support a shelf-life of greater than 10 days for fresh chilled beef, lamb and pork held at 3°C to 8°C.

The shelf-life of fresh red meat is of great significance to the industry. Therefore, these project findings should be widely disseminated in order to maximise benefit and value from this project to the red meat industry.

Using a risk assessment approach, it was established that current practice provides a high level of protection with respect to non-proteolytic *Clostridium botulinum*; thus, there is no evidence that currently-applied shelf lives of fresh chilled beef, pork and lamb combined with current production standards are unsafe.

The ability not to be constrained by a 10-day shelf-life, as indicated in present FSA guidelines (2017) and the freedom to adopt a shelf-life greater than 10 days at 3°C to 8°C for fresh chilled beef, lamb and pork can bring significant benefits to producers, processors and retailers. But, just as importantly, there it has the potential to bring environmental and consumer benefits through lower in-home wastage.

Further work for this research project

The research paper has been published on the BMPA website (www.britishmeatindustry.org) and is free to download. The BMPA and the MLA have agreed to fund a peer review of this work which will be managed by QIB Extra at the Quadram Institute in Norwich.

In addition, the BMPA has written to the ACMSF (Advisory Committee on the Microbiological Safety of Food) to present the findings of this research. Professor Mike Peck will be leading this on behalf of the BMPA. The hope is that the FSA will now review the 2017 guidance and allow more flexibility, as all food manufactures have when they carry out their due diligence, in setting the total shelf life of any food product.

EXPERTVIEW

Norbert Hartwig
Director, Research and Development, Eagle Product Inspection

How advanced inspection delivers greater traceability for quality assurance

Traceability is becoming an expectation in the supply chain. Consumers increasingly want a 360-degree picture of what they are eating. Overseeing organisations seek to ensure a safe food supply under their purview and demand a strong, validated, food-safety culture. Manufacturers need to be able to satisfy the demands of their customers, regulators and end consumers.

> *"Next generation X-ray systems allow you to capture information and images that hold the key to what was inspected, when, how and by whom"*

IT'S A topic of much industry discussion, but where is technology today in achieving demonstrable traceability?

Next generation X-ray systems allow you to capture information and images that hold the key to what was inspected, when, how and by whom, eliminating any guesswork. It's literal transparency.

Thanks to advances in technologies, today's inspection systems and software are able to provide item-level traceability. Depending on how they set up the system, the user of an advanced X-ray machine with the latest-generation software can get a virtual product snapshot that is time and date coded for simple storage and retrieval.

The ability to provide such traceability was a major impetus behind recent upgrades to Eagle's technology, which links inspection data to a unique identifier printed on each item. Features such as unique printed identifiers and unique machine operator logins are great for tracking products through a facility, but there are other benefits. Real-time analytics are available for complete information on products inspected. One can also use analytics to determine things like the volume of products being inspected, what is being rejected and why, and who conducted the test.

Ultimately, having information on an item-by-item basis protects your brand and reflects your commitment to food safety and quality. A manufacturer is more prepared when an auditor comes and asks for a traceability test or if a customer makes a complaint.

At Eagle, we've seen an uptick in providing demonstrable traceability, and we expect that to continue. This is no longer a reactive climate. This is a genuine and likely permanent shift in mindset accompanied by exciting innovations in software and detection capabilities.

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Proteomics of Shellfish Allergens: Using LC-MS to Detect Important Food Borne Allergens

In 2004 the US Food and Drug Administration (FDA) passed a law that describes the requirements for allergen labelling and customer protection (Public law 108 – 282 Title II). As with other laws found in other countries, this law seeks to protect food allergy sufferers; which makes up about two percent of adults and about five percent of infants/young children of the population.

THE LAW hopes to decrease the number of annual emergency treatments, and food allergy related deaths. The number of reported cases in 2000 was 121, as opposed to 35 a decade earlier. Such evidence suggests the public, and particularly those with food allergies, could benefit significantly from routine testing of food products before their release for consumption. It is critical that before any such test can be developed, a clear understanding of the composition of the allergen is required.

Proteomics is the study of the protein complement of an organism or part thereof. It provides a means of detecting characteristic molecules, such as allergenic proteins, which could ultimately be used in a routine food testing assay.

In this webinar, we will describe on-going work regarding the proteome analysis of shellfish, specifically prawns and oysters, as a first stage towards the development of a routine LC-MS food test. We will discuss the steps involved, from the initial analysis of the scientific literature and sample preparation to data review and allergen target selection. We will share data from the initial detection and identification of shellfish proteins by LC-QqTOF as well as some early results of targeted allergen analysis using LC-QqQ mass spectrometry, before concluding with our aims for the second phase of the project.

Key learning outcomes:

- Gain an understanding of the importance of food testing and food labelling
- Learn about a specific process used for extracting proteins from prawn and oyster tissue
- Gather a greater understanding of the process involved in developing a new food testing assay using LC-MS
- Learn about the application of proteomics to food analysis from international experts

28 MAY 2019

3.00PM (GMT)

KEYNOTE SPEAKER:

Michelle Colgrave
Professor of Food and Agricultural Proteomics, CSIRO

Michelle Colgrave is a Professor of Food and Agricultural Proteomics at CSIRO and holds a joint position in the School of Science at Edith Cowan University. Michelle is using proteomics, the study of proteins, using mass spectrometry (MS), to help identify key proteins that will benefit Australia's food and agriculture industries and improve human health.

KEYNOTE SPEAKER:

James Broadbent
Research Scientist – Proteomics, CSIRO

James Broadbent is Proteome Research Scientist within CSIRO's Food Futures research flagship. James' work principally involves measuring proteins and proteomes in crops and food products, for the improvement of agriculture practices and food safety.

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"I'm continually **learning"**

Helen Sisson, Group Technical Director at Birmingham-based food manufacturer, 2 Sisters Food Group, tells *New Food* about her role within the company

Tell us about your day-to-day role and responsibilities at 2 Sisters

My role at 2 Sisters is Group Technical Director, where I'm responsible for food safety, health and safety and sustainability – including all environmental aspects of the business.

No two days are the same, there is a huge variety in my role; not just the breadth of the topics that it covers but also the different activities that I get involved in.

One day you can be in your wellies, hairnet and white coat walking around the factory floor, another day you can be meeting with customers, or working with industry leaders discussing non-competitive industry challenges that we can tackle together.

I will spend time with the leadership team on business strategy but also with my functional teams, looking at functional strategy, priorities and improvement programmes – it's a very broad agenda.

There are, of course, challenges, such as a food safety incident, where you revert to incident management and deal with whatever is thrown at you!

How have your roles to date prepared you for this latest role – what attracted you to it?

I've always worked in the food industry; my career began in the dairy industry and then I moved into cooked meats. My last role was working for a large manufacturer producing a range of product categories such as sandwiches, soups, ready meals, cakes and desserts. I've been lucky enough to get

ABOVE LEFT: Helen Sisson

ABOVE RIGHT: The company manufactures for clients including Asda, Co-Op, Marks & Spencer and Tesco.

involved with a wide range of food with the same broad range of responsibilities.

I'm a techie by nature, but I have looked after health and safety and environment for many years now, plus I am also involved with sustainability issues, an area that is increasingly important to the sector.

At 2 Sisters I am learning about a new area of food production and a new vocabulary in working with poultry. It is fascinating to learn about the end-to-end supply chain, the agricultural side and some of the nuances such as campylobacter.

It is both new and a challenge but it's also an opportunity, as I'm continually learning, which is great.

What are your plans for your new job, with relation to 'lean' sustainability, to implementing food safety and to enhancing the brand's reputation?

I've spent the first couple of months getting to know the business, visiting as many of the sites as possible and meeting the teams.

I've been seeking feedback from a wide variety of stakeholders, including the group's customers, to understand what we do well and what we can do differently.

We are designing our strategy for the Technical function (Technical, Health and Safety and Sustainability); what we will deliver and how we will deliver it, something that will support continuous improvement in our standards, performance and, ultimately, our reputation.

We will build upon our capability to deliver our strategy, ensuring that we have good governance, with robust procedures and processes in place.

The role is attractive, as it offers the diversity that interests me in terms of the products and the breadth of role it covers. This is also a business going through transformational change, offering me is an exciting opportunity to play my part at both a business and a functional level.

EXPERTVIEW

Staffan Karlsson
Global Marketing Manager for Belts at IPCO (previously Sandvik Process Systems)

"stainless steel is more cleanable than the two different plastic surfaces tested according to the culturing results. The difference is more significant for damaged surfaces"

Stainless steel conveying for enhanced hygiene

The benefits of using steel belts in meat-processing operations are myriad. We take a look at some of them.

THE PROPERTIES of stainless steel – chemical and bacterial neutrality, corrosion resistance, inherent inertness, and ease of sanitising – make it the default choice for applications across the food industry, and these qualities are particularly relevant to meat processing, where the need to minimise risk of bacterial build-up is paramount.

This applies to every aspect of production, right down the conveyor belts used in deboning, cutting or sorting operations, an area in which the choice of a stainless steel belt over plastic alternatives can have a significant impact in terms of maximising hygiene standards.

One of the greatest threats to a sanitary meat-processing environment is the formation of biofilm on work surfaces, and unless cleaning is complete and effective, this can lead to the growth of harmful bacteria and pathogens.

Being perfectly flat and smooth, stainless steel has no gaps, textures or hidden areas in which microbes could hide, and allows quick and easy cleaning and sanitising using heat, pressure, brushes, detergents or chemicals. It's also extremely tough and resistant to damage and scratches, and this is very important.

Efficient cleaning enables high standards of hygiene to be maintained. This was confirmed by scientists at Finnish food laboratory VTT Expert Services Ltd, who found that that risk of bacterial build-up can be reduced, simply by upgrading to a stainless steel conveyor.

The research looked at the 'cleanability' of three types of conveyor belt: stainless steel (AISI 301), solid plastic, and a plastic conveyor of slat construction. All three were tested in pristine condition and also with knife damage to replicate everyday wear.

The conclusion was that: "stainless steel is more cleanable than the two different plastic surfaces tested according to the culturing results. The difference is more significant for damaged surfaces."

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21-24 JULY 2019

KENTUCKY, USA

Each year, the **International Association for Food Protection (IAFP)** hosts its Annual Meeting in North America, providing attendees from around the world with information on current and emerging food safety issues, the latest science, innovative solutions to new and recurring problems, and the opportunity to network with thousands of food safety professionals. **This year, attendees at IAFP 2019 will 'Reach for the Finish Line with IAFP!' at the Kentucky International Convention Center in Louisville, Kentucky, Sunday, 21 July - Wednesday, 24 July.**

THE IAFP Annual Meeting is attended by more than 3,600 of the top industry, academic and governmental food safety professionals from six continents. This renowned event owes its reputation and success to the quantity, quality and diversity of each year's program; the quality and relevance of exhibitors sharing the latest in available technologies; leading experts speaking on a variety of timely topics; and special recognition of outstanding professionals and students for their contributions in the food safety field.

Six **Pre-Meeting Workshops** will take place prior to the conference in Louisville. They include a one-day workshop, 'Using Data and Statistical Analysis to Guide Food Safety Decision Making,' on Friday, July 19; and two concurrent one-day workshops, 'Introduction to FDA-iRISK

4.0: A Comparative Risk Assessment Tool with New Features and Case Studies' and 'Principles for Establishing and Extending Shelf Life,' on Saturday, 20 July. Two one-and-a-half day workshops will be held on Friday, 19 July and Saturday, 20 July: 'Validating Pasteurisation Processes for Low-Moisture Products,' and 'Whole Genome Sequencing: A Tutorial and Hands-on Workshop to Understand and Implement This Breakthrough Technology.' A two-day workshop, 'Developing Environmental Monitoring Programs for Small and Midsize Processors,' will take place on Friday, 19 July and Saturday, 20 July. Led by experts in their respective fields, these Pre-Meeting Workshops give attendees a jump start on their food-safety learning experiences.

Saturday afternoon's **Welcome Reception** provides those who have arrived throughout the day the chance to mingle, network and meet old and new acquaintances before four solid days of meetings and events.

Committee and 27 Professional Development Group (PDG) meetings fill the day on Sunday, 21 July. Membership in any PDG is open to all attendees and offers the opportunity to share a wealth of knowledge and expertise, which helps guide the efforts of the Association.

Sunday evening's **Opening Session** includes an update on the IAFP Foundation and presentations to four Fellow Award recipients; eight Travel Award recipients; and 20 Student Travel Scholarship recipients. The **Ivan Parkin Lecture** follows, with guest speaker **Barbara Chamberlin, PhD**, New Mexico State University in Las Cruces, presenting 'The Power of Play: Using Media to Educate our Stakeholders.'

The evening continues with a **Cheese and Wine Reception** in the Exhibition Hall, where 200 exhibitors will showcase the latest in food-safety technology. Exhibits will be on display from a variety of companies, providing attendees with another avenue to exchange ideas and information on existing technologies and applications, new concepts and innovative designs, and the availability of products and services. The popular 'Explore the Floor' contest will offer attendees the opportunity to have an exhibitor card stamped while visiting with participating exhibitors to learn more about their products. Fully stamped cards can be entered in a prize draw at the conclusion of the event.

Attendees will also be able to bid on dozens of unique and desirable items included in the IAFP Foundation's Annual Silent Auction. Items from around the world are donated by Members, attendees, organisations, sponsors, exhibitors, and IAFP Affiliates. This lively event provides valuable funds for the Foundation to help support vital programs, which include (in part) key lectures at Annual Meeting; travel for speakers at IAFP global meetings; and travel for recipients of the Student Travel Scholarships and Travel Awards to attend IAFP's Annual Meeting.

Three full days of sessions, along with poster and technical presentations, take place on Monday, Tuesday and Wednesday. **IAFP 2019** will include more than 1,250 presentations, including 73 symposia; 22 roundtables; 818 poster presentations; and 136 technical presentations, all of which were carefully reviewed and selected by the IAFP Program Committee. Educational sessions are dedicated to timely coverage of key issues and cater to multiple experience levels.

The **John H. Silliker Lecture**, scheduled for Wednesday afternoon, closes the educational and informative conference. This year's guest speaker is **Robert Tauxe, MD, MPH**, Centers for Disease Control and Prevention in Atlanta, Georgia. His presentation is entitled, 'From Outbreak Catastrophes to Clades of Concern, How Whole Genome Sequencing Can Change the Food Safety Landscape.'

IAFP 2019 comes to an end with Wednesday evening's **Awards Banquet**, where professionals will be honoured with various awards for outstanding contributions to food safety and IAFP throughout their careers. Students presenting winning posters during the Annual Meeting will also be recognised for their research in the field of food safety.

IAFP and its more than 4,200 food safety professional members are committed to **Advancing Food Safety Worldwide** through the mission: *"To provide food safety professionals worldwide with a forum to exchange information on protecting the food supply."* Now in its 108th year, IAFP is proud to produce the leading food safety conference worldwide. ■

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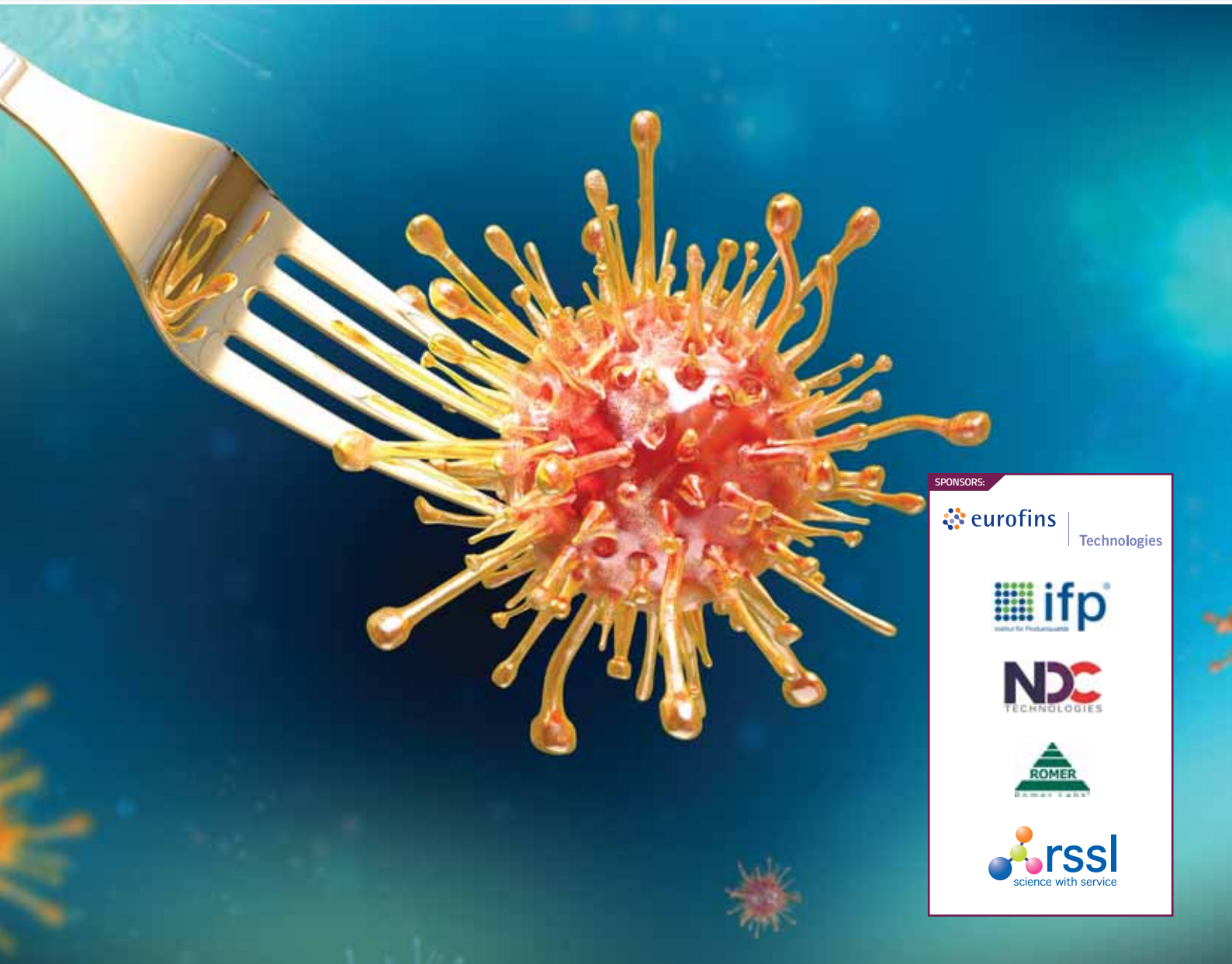
FOOD SAFETY

Professor Lucy Robertson and colleagues explain why foodborne parasites are important – and why they remain the neglected pathogens, despite their significant impact.

Jessica Sage, food safety and quality consultant at Reading Scientific Services Ltd (RSSL), reviews the key issues that are influencing developments in the vegan and vegetarian sector.



The Neglected Pathogens – why foodborne parasites are relevant too

In the summer of 2018, 2,299 laboratory-confirmed cases of cyclosporiasis in the US were reported to the Centers for Disease Control and Prevention, with at least 160 people hospitalised. *Professor Lucy Robertson*, Chair of a COST Action on foodborne parasites, along with Working Group leaders from the Action, explains why foodborne parasites are important – and why they remain the neglected pathogens, despite their significant impact.

THE INCREASED Incidence of cyclosporiasis in the US last year was not a one-off event. In 2017 there were 1,065 laboratory-confirmed cases in the US, with 384 being reported in 2016, and 546 reported in 2015. In 2014 there were 304 cases, while 2013 was another big year, with 631. Although the infection sources are often not identified, many cases have been associated with fresh produce, including imported coriander, pre-packaged vegetable trays, mixed salads from a well-known fast-food chain, basil, and various other fresh produce. This particular foodborne parasite (FBP) seems to return to US consumers on an annual basis; but why does this happen and how can we prevent it happening again?

> *"we can expect foodborne parasitic diseases to be underdiagnosed, thus skewing our understanding of the prevalence of these pathogens"*

Other foodborne parasites making a splash during 2018

In addition to cyclosporiasis bothering US-based consumers in 2018, other foodborne parasitic diseases affected consumer health last year.

In Santa Maria, Brazil, an outbreak of toxoplasmosis occurred. Over 800 cases had been registered by October 2018, including 114 in pregnant women and three foetal deaths.

Another parasite, *Trichinella*, caused several disease outbreaks in Argentina that same year; one in Pehuajó resulted in over 160 infections, one in Canals in Córdoba Province resulted in over 230 cases, and in Bahía Blanca over 100 infections were reported in September. Most outbreaks were due to consumption of sausages or salami.

FIGURE 1

LEFT: Single tapeworm (*Taenia saginata*) from a patient in Belgium in July 2018 (Photo credit, Idzi Potters, Institute of Tropical Medicine, Antwerp, Belgium)

Symptoms included fever, severe muscle pain, headache, ocular symptoms, diarrhoea and vomiting.

Meanwhile, in spring 2018 the Japanese health ministry issued a warning about the parasite Anisakis in raw fish after several reports of infection in various areas of Japan, with acute epigastric pain being the main symptom. On a smaller scale, in Norway, sharing home-pressed apple juice with work colleagues in the autumn resulted in those colleagues reporting in sick one week later with violent diarrhoea due to infection with *Cryptosporidium parvum*.

This snapshot illustrates the diversity of both symptoms and food vehicles associated with parasites. It also leads us once again to question why parasites are the neglected group among foodborne pathogens, and what their relative importance is.

Some of these issues have previously been raised[1] and problems specific to FBP that have been highlighted include their complexity, diagnosis and transmission attribution difficulties, and the lack of standard detection methods. We address some of these below, using examples of different parasites that also illustrate the importance and impact of these foodborne pathogens.

Foodborne parasites: they're complicated

One problem with parasites is, perhaps, their enormous diversity. Some are protozoa: minute, single-celled organisms that, like bacteria, can only be seen with a microscope; others (such as *Trichinella*) are worms, but are also microscopic; while some (like *Anisakis*) are over 1cm long. Some are even bigger: tapeworms (cestodes) can be several metres in length (see ***Figure 1***), although their transmission stages (the part consumed with food to pass on the infection) are generally smaller. Most important, however, is the fact that FBP lifecycles vary tremendously. Some FBP transfer relatively simply from infected host to infected host by transmission stages excreted in faeces contaminating food. Others, however, may go through one or more intermediate hosts, and the infectious stage may end up in the flesh of a fish or animal, which is later ingested. Thus, to understand how food may contain an infective parasite stage requires knowledge about complex lifecycles. Excellent lifecycle illustrations are available (see, for example, https://www.cdc.gov/dpdx/az.html) – but it is questionable how often these are consulted by those in the food industry.

Confusingly, some parasites may have several possible routes of transmission to humans; different food types may be associated with transmission of different life stages of the same parasite, and the resulting symptoms may also differ. This is the case for some protozoan parasites, but is particularly important, although much neglected, for some tapeworms.

For example, the pork tapeworm, *Taenia solium*, may infect humans when undercooked pork from an infected pig is consumed; cysticerci (tapeworm larvae) in the pork may result in a tapeworm developing in the intestine of the person. Although this worm may be several metres long and cause abdominal symptoms, the infection is considered relatively mild. However, *Taenia solium* eggs excreted in the faeces of an infected person may contaminate fresh produce, and if these are consumed then the cysticerci may develop in the unfortunate end consumer. Cysticerci in the central nervous system can cause serious symptoms and the infection may even be fatal. Indeed, *Taenia solium* is considered to be the most significant FBP globally, causing around 28,000 deaths.[2,3]

As illustrated, being vegetarian will not prevent infection by FBP parasites.

Another example is *Toxoplasma gondii*. Calculations of disability adjusted life years (DALYs – a metric including both mortality and morbidity), showed that this foodborne pathogen has a high disease burden in the Netherlands,[4] and elsewhere.[5,6] As with other FBP, this burden is due to chronic, long-term sequelae. Transmission of *Toxoplasma* to humans can occur during various parasite stages, via such mediums as undercooked meat, fresh produce, or milk (see ***Figure 2***).

ABOUT THE AUTHOR

LUCY J. ROBERTSON (Chair of COST Action FA1408) is a Professor at the Department of Food Safety and Infection Biology, Faculty of Veterinary Medicine, Norwegian University of Life Sciences, Adamstuen Campus, Oslo, Norway.

ABOUT THE AUTHOR

JOKE WB VAN DER GIESSEN (Leader of Workgroup 1 of COST Action FA1408) works at the Centre for Infectious Disease Control Netherlands, National Institute for Public Health and the Environment, Bilthoven, the Netherlands.

FIGURE 1

(Photo credit EFSA, 2018)

Foodborne parasites and the slow disease movement

One reason why both consumers and food producers underestimate the likelihood and impact of FBP is due to the often-long period between ingestion of the parasite and onset of symptoms from the resultant infection. This means that pinpointing the meal from where the parasite originated – or, for some parasites, whether it was foodborne at all – is difficult.

It is simply hard to make the connection between something that was eaten a while ago and being ill now. Generally, when people blame something they ate for feeling unwell, they point to what they consumed the day before. However, for FBP the period between infection and symptoms can sometimes be several days, but more usually weeks or months, and even years (see Table).

Diagnosis may also be delayed, as the symptoms are often diverse and not pathognomonic, or because appropriate diagnostic tests are not requested. For example, opisthorchiasis, which is transmitted to people by ingestion of undercooked freshwater fish, is often asymptomatic, but may cause fever, abdominal pain, diarrhoea, fatigue, and diffuse myalgia. Furthermore, untreated chronic infection may result in the late development, after several years, of cholangiocarcinoma, a malignant cancer of the bile ducts with very poor prognosis. Thus, early diagnosis and appropriate treatment are essential. However, several outbreaks of opisthorchiasis in Italy between 2007 and 2011 indicate that many physicians in Europe are not really aware of this disease. This may result in

people living undiagnosed and at risk of developing cholangiocarcinoma.[1]

In essence, we can expect foodborne parasitic diseases to be underdiagnosed, thus skewing our understanding of the prevalence of these pathogens. Our current awareness of the situation is probably only the tip of the iceberg.

Foodborne parasites: we often don't look for them in food

It may seem logical to look for FBP in food to ensure that it is safe for human consumption, and for some parasites (*Trichinella, Taenia saginata cysticerci*, *Anisakis* larvae) in some foods this is indeed the case – although the method sensitivity for some parasites can be low.

However, for other FBP, methods to detect parasites in food are either lacking entirely or are impractical and expensive. Legislation that demands that food be checked for FBP is lacking for many FBP. For example, although *Toxoplasma* is a very important FBP, meat is not examined for this parasite.[7] Furthermore, even when outbreaks do occur, implicated produce may not be checked – often due to the prolonged period between infection, symptoms and diagnosis meaning that the implicated food has already been consumed or discarded. This complicates proper source attribution, outbreak investigation, and tracking the origins and routes of infection. For example, an outbreak of cryptosporidiosis in the UK in 2012 involving hundreds of cases was associated with consumption of pre-cut mixed salad leaves, yet suspect foods were not analysed.[8] Several reasons were given for this – the main one being that, from the first outbreak, over three weeks were estimated to have elapsed since exposure and, given the short shelf-life of salad, none of the contaminated product was likely to be available for testing.

What have we learned and where are we going?

Returning to the 2018 outbreaks of cyclosporiasis in USA, one in a recurring tide, it is clear that we still have considerable progress to make regarding FBP and their control. For some foods, salting, drying, freezing, or heating will reduce parasite infectivity, but data are scarce compared to those available for bacteria, and the means to assess parasite viability it is not always obvious.[9] For minimally-processed foods or fresh produce, control options are few. This complicates addressing FBP in HACCP-based food safety control systems. With growing trends for eating ›

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> *"for FBP, the period between infection and symptoms can sometimes be several days, but more usually weeks or months, and even years"*

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TABLE **FBP: most commonly associated foods usual period between infection and development of symptoms**

Pathogen	Diseases (common names)	Most commonly associated foods[1]	Approximate incubation period (time between infection and symptoms)
Other foodborne pathogens (for comparison)			
Campylobacter (bacteria)	Campylobacteriosis	Poultry	2 to 5 days
Norovirus (virus)	Viral gastroenteritis	Shellfish,	1-2 days
Salmonella (bacteria)	Salmonellosis	Eggs, meat, dairy, fresh produce	6 to 72 h
Foodborne Parasites[1] (group)			
Anisakidae (nematode)	Anisakiasis	Marine fish, crustaceans, cephalopods	Hours (gastric), 1-2 weeks for gastrointestinal
Ascaris spp. (nematode)	Ascariasis	Fresh produce	1 week (respiratory symptoms), 2 months (intestinal)
Balantidium coli (protozoa)	Balantidiasis	Fresh produce	Several days (minimum)
Cryptosporidium spp. (protozoa)	Cryptosporidiosis	Fresh produce, fruit juice, dairy	Usually 1 week
Cyclospora cayetanensis (protozoa)	Cyclosporiasis	Fresh produce	Usually 1 week
Diphyllobothriidae (cestode)	Diphyllobothriasis	Fish (freshwater and marine)	Weeks
Echinococcus granulosus (cestode)	Cystic echinocccosis (CE)	Fresh produce	Several years
Echinococcus multilocularis (cestode)	Alveolar echinococcosis (AE)	Fresh produce	SEVERAL YEARS
Entamoeba histolytica (protozoa)	Amoebiasis	Fresh produce	2-4 WEEKS
Fasciola (trematode)	Fascioliasis	Fresh produce	Usually several weeks
Giardia duodenalis (protozoa)	Giardiasis	Fresh produce	Usually 1 week
Hetrophyidae (trematode)	Heterophyiasis	Fish (freshwater and brackish water)	1-2 weeks
Opisthorchiidae (trematode)	Opisthorchiasis & chlonorchiasis (potentially chlolangiocarcinoma)	Fresh water fish	Variable; 2 weeks minimum
Paragonimus spp. (trematode)	Paragonimiasis	Freshwater crustaceans	Variable; weeks or months
Sarcocystis spp. (protozoa)	Sarcocystosis	Beef and pork	Hours to days
Spirometra spp. (cestode)	Sparganosis	Frog, snake meat	Variable; weeks or months
Taenia saginata (cestode)	Taeniosis	Beef	Months
Taenia solium (cestode)	Taeniosis	Pork	Months
	Cysticercosis	Fresh produce	YEARS
Toxocara spp. (nematode)	Toxocariasis (visceral larval migrans & ocular larval migrans)	Fresh produce	Unknown; weeks
Toxoplasma gondii (protozoa)	Toxoplasmosis	Meat and organs, fresh produce, dairy	1-4 weeks for acute; reactivation can occur
Trichinella spp. (nematode)	Trichinosis	Meat	1-2 days for enteral phase, but 2-8 weeks for parenteral phase
Trichuris trichiura (nematode)	Trichuriasis	Fresh produce	Around 3 months
Trypanosoma cruzi (protozoa)	Chagas Disease	Fruit juice	Around 1-2 weeks, can be longer

1: Parasite info based on FAO/WHO , 2014

minimally-processed food products, animals raised outdoors, and organic farming systems, the likelihood of our food containing FBP will likely increase.

Fundamental questions remain about the epidemiology, survival and virulence of FBP. In addition, methods for detecting different parasites in various kinds of food, and removal or inactivation of FBP are not optimised. Answering these questions is fundamental, and initiatives to address them are appearing as knowledge gaps are recognised by relevant agencies. However, until both food suppliers and consumers become aware of FBP, finding answers to these questions will be a prolonged process.

ACKNOWLEDGEMENT

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Challenging issues for **vegan** and **vegetarian** food manufacturers

Skyrocketing demand for vegan and vegetarian foods has highlighted a number of manufacturing concerns – particularly with respect to on-pack claims. Here, *Jessica Sage*, food safety and quality consultant at Reading Scientific Services Ltd (RSSL), reviews the current state of play and key issues that are influencing developments.

PLANT-BASED eating was one of the biggest food trends of 2018. Seen more as a lifestyle choice, there are a wealth of reasons why people are shunning animal food products, including the perceived health and wellness benefits, as well as ethical, welfare and environmental concerns. Whatever the motivation, this dietary choice appeals to a wide consumer audience – an advantage, which has undoubtedly helped to fuel its transition into the mainstream.

In fact, more people than ever are eating vegetarian or vegan products. 56 percent of UK adults are now choosing to do so, while the number of US consumers identifying as vegan has increased 500 percent since 2014 to reach six percent of the population.

This marked shift in eating habits has created a buoyant category. Plant-based new product development (NPD) reportedly increased globally at 11 percent compound annual growth rate (CAGR) during 2013-17 and related on-pack claims increased 62 percent in the same period. In the UK, the share of new meat-free products carrying a 'vegan' or 'no animal ingredients' claim nearly doubled during 2014-17. This upward trajectory shows no signs of slowing.

Unsurprisingly, product developers have been quick to respond with a raft of innovative food and drink products, with vegetarian and vegan options appearing at a rapid rate across categories. These range from dairy alternatives, where the number of product launches has more than doubled over the last five years globally, to headline-grabbing meat substitutes aimed at a discerning flexitarian audience. Manufacturers continue to raise the bar in terms of taste, nutritional profile and eating enjoyment.

However, as the industry moves to capitalise on this significant opportunity, there is an underlying current of concern. It is becoming increasingly clear that vegan and vegetarian products require a carefully considered manufacturing strategy – after all, the stakes are high. Recent widespread media reports of both vegan and vegetarian products being contaminated with animal-derived ingredients show the impact of such incidents in terms of shaking consumer confidence and potentially damaging brand reputations.

Despite the current lack of legal framework defining what constitutes a vegan or vegetarian claim, producers must ensure that every available step is taken to substantiate these claims.

Clarity on claims

One of the main issues centres on the use of on-pack claims. With regard to vegan and vegetarian labelling, the European Commission has announced that it intends to begin the process of establishing a legal definition of both descriptors in 2019, as part of its ongoing Regulatory Fitness and Performance Programme (REFIT). This news has reportedly been warmly welcomed by both the European Vegetarian Union (EVU) – which has been lobbying the EU for such action since 2008 – as well as the industry association, Food Drink Europe (FDE).

In the meantime, many manufacturers are choosing to work with the Vegetarian Society and/or Vegan Society for permission to feature their approved trademarks on packs. The process of registration with these organisations is relatively straightforward and, importantly, is carried out per product rather than a blanket approval of the company in question. However, while visibility of such a logo undoubtedly sends a clear message in terms of the ethical aims of the organisation behind it, it is not a categoric guarantee of the complete absence of animal-derived ingredients. In fact, certified products are also permitted to carry a 'may contain' statement. This means that, for example, both the Vegan Society trademark and the statement 'may contain traces of milk and egg' could appear on the same pack. This is prompting high-level industry discussions and demand for guidance regarding the necessary controls for manufacture of vegan and vegetarian products.

Some of the confusion stems from the disparity between the current legal position – where claims such as 'vegan' and 'vegetarian' are voluntary and covered by the Food Information for Consumers Regulation (EU FIC) – versus consumer perception that such labelling can be interpreted in the same way as allergen food safety advice. This is a potentially dangerous assumption, as tragically highlighted in recent media coverage.

However, while there are currently no EU-approved best practice procedures in place, there are several practical strategies that manufacturers can adopt to ensure they are making every effort to substantiate these claims on products. Much can be learned from allergen management best practice; an area that provides valuable guiding principles in this context.

Key considerations

When considering whether a product should carry a vegan or vegetarian claim, a risk assessment should be conducted in order to identify the risks at each stage of the production process that could lead to the claim being invalid. The risk assessment should consider the entire process, from supply of raw materials through to despatch. Some examples of areas for consideration are as follows:

Supplier assurance

Ongoing communication between supplier and manufacturer is crucial. Implementing a supplier approval process is standard practice; allowing manufacturers to determine which materials are handled on site and any corresponding cross-contamination risks. But what happens if conditions at the supplier site change?

This is a fast-paced industry, which means that an approved supplier may suddenly start handling an animal-derived ingredient on site; potentially creating an issue for materials supplied for use in vegetarian and vegan products.

To avoid this situation, robust supplier quality assurance processes and regular audits must be in place – not only to minimise the risk of unintentional animal-derived products in materials, but also to ensure that any site developments are immediately flagged up.

"In the UK, the share of new meat-free products carrying a 'vegan' or 'no animal ingredients' claim nearly doubled during 2014-17. This upward trajectory shows no signs of slowing"

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Product scheduling

Where dedicated facilities are not available, manufacturers must address the issues of effective prioritisation, and whether the addition of vegan/vegetarian lines requires a new way of thinking.

From a commercial perspective, it makes sense to decide what should be made and when based on customer demand; however, when it comes to preventing cross-contamination, other issues must be considered. In this context, the concept of 'allergen build' can be a useful reference.

In practical terms, the production run would start with products containing no animal-derived ingredients (vegan), followed by those containing milk or egg but no meat (vegetarian). This avoids introducing a potential cross-contamination risk or having to stop production for a cleaning intervention.

This approach is ideal, and if the manufacturer has no other considerations such as allergens, or claims such as 'organic' carried by some products, this is fairly straightforward. However, in the real world situations are not so clear-cut, and serious consideration must be given to the claims that take priority. Food safety considerations must always take priority over food quality, but this is complicated by the milk- or egg-allergic consumer assuming that a 'vegan' claim is equivalent to a 'milk-free' or 'egg-free' claim.

Physical segregation or dedication

In an ideal world, manufacturers would have a separate line for vegan products, another for milk-free, and so on – but clearly that's not a commercially viable proposition.

Instead, all risks where unintentional presence of material could occur must be assessed. For each of these, the manufacturer must put controls in place that can be shown to manage these risks effectively. Some such other possible controls include dedicated production lines or parts of lines, or physically segregated lines. Consideration must be given to the risk of potential airborne contamination from such foods as powders or seasonings.

Other possible controls could be floor-to-ceiling curtains, or temporary physical barriers such as walls but evidence is needed to demonstrate their efficacy. It's not enough to simply assume the chosen control method is working; validation is critical.

Cleaning as a control

On shared lines, cleaning is an essential control between products that contain animal-derived ingredients and those that don't. The cleaning procedure needs to be validated to demonstrate that it is effective at removing the animal-derived material from the line and minimising the risk of carry over to the next product. However, this is not necessarily a straightforward task due to the analytical testing options that are currently available.

It might be the case that the cleaning validation process highlights a need for improvements to the cleaning procedure, wherein any possible improvements should be made before the validation process begins again. It could also be the case that the validation process demonstrates that, despite all possible steps being taken to attempt to improve the procedure, the cleaning cannot effectively remove the target to a consistently acceptable level and carry over into the next product cannot always be prevented. In this case, the use of claims around vegan or vegetarian status should should potentially be reconsidered.

Analytical testing

When looking for the presence of animal species within a product or ingredient, DNA detection using Polymerase Chain Reaction (PCR) is the most commonly adopted method. This method

more people than ever are eating vegetarian or vegan products

is generally very sensitive and can detect trace amounts of DNA within a sample. However, this method usually requires the user to have identified the species that is the likely source of contamination, as the test is targeted and will only look for specific DNA sequences. This presents a challenge for those who wish to look for potential contamination from unknown sources.

To attempt to meet the industry need for a more generic screening method, RSSL is currently investigating a vertebrate screening test that, as the name suggests, will check for the presence of DNA from any animal with a backbone. This has potential to simplify the testing process for industry and make due diligence surveillance more straightforward. However, any generic screening test will have inherent limitations.

One significant limitation of this screening method is that human DNA is likely to be found; this is an unavoidable consequence of human involvement in the food production process. While validating this method, therefore, RSSL is looking to take steps to ensure that likely levels of this carry-over are assessed and the detection limit of the test adjusted accordingly. Being a screen, the test will also not specify the source of the DNA, so any positive results will require further analysis in order to fully identify them. Converting a DNA test result into a weight-for-weight contamination level is a real challenge because the units are not easily comparable.

Other considerations when utilising species-specific tests include the fact that a cow DNA test is unable to distinguish between DNA from milk and DNA from beef. Similarly, targeting chicken may lead to a positive result but it is not possible to know if this is due to the presence of chicken DNA or DNA from egg.

All such considerations mean that lateral thinking when picking a target for testing is key, and a good laboratory with the right expertise should be able to guide manufacturers through this decision-making process.

An example might be when looking at cleaning validation, where using the target of concern for the clean might not actually be the best target in order to validate the clean. For instance, when validating the cleaning of a line that is used to produce beef lasagne, followed by a vegetarian product containing cheese, it would be natural to assume that the beef should be the target for the validation, as this is the carry-over concern. However, given the fact that quantifying levels of contamination from a DNA test is difficult, and that the milk in the lasagne sauce is likely to be harder to clean from the line, it could be advised that the most effective target for this validation would actually be milk, as there are quantitative sensitive ELISA tests available for it.

It can be an initially uncomfortable decision to make, but by always choosing the hardest-to-clean substance as the target and validating that it has been removed to an acceptable level, other materials of greater concern that are easier to clean are likely to have been cleaned away too.

Building knowledge

Of course, this is just the starting point in establishing robust manufacturing processes and bringing regulatory rigour to the vegan and vegetarian sectors.

Ensuring everyone who works at the manufacturing site is properly trained is vital – as is communicating the reasons behind certain procedures and why they must be followed. Otherwise, corners can be cut and things can go wrong. The importance of effective training cannot be emphasised enough.

Ongoing due diligence should also be part of the strategy. A series of regular checks will help to provide evidence that everything is as it should be, or potentially highlight that it's not, in which case corrective action can be taken swiftly.

> *"Food safety considerations must always take priority over food quality, but this is complicated by the milk- or egg-allergic consumer assuming that a 'vegan' claim is equivalent to a 'milk-free' or 'egg-free' claim"*

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Protein of the Future

A UK-based startup is trying to solve the increasing demand for protein by introducing the western world to cricket flour: an innovative protein source of the same quality as meat but with the sustainability of plants. *Radek Hušek*, the company's co-founder, explains the why and how.

ABOVE: Paper cartons maximize the surface area for crawling for over 10,000 crickets.

IT ALL started with a book called *Edible Insects, Future Prospects for Food and Feed Security*, published in 2013 by the United Nation's Food and Agriculture Organization (FAO), which describes the untapped potential of edible insect farming. I and my co-founders, Daniel Vach and Nicolas Bery, stumbled upon this book independently of one another, but a common mission – to help the western world take advantage of this amazing new protein source – brought us together.

The first thing that stood out when studying insects as a potential human food was their incredible resource efficiency. To produce the same amount of protein as cattle, crickets need twelve times less feed, fifteen times less land, and two thousand times less water. Insects also thrive in dense populations and produce 100 times less greenhouse gas than cattle.

Moreover insects do not have nociceptors, nerves that transmit pain. This is significant when it comes to slaughter: crickets naturally go into a hibernation-like state called diapause when the environment turns inhospitable; a very cold morning is often enough to trigger it. The farmer just has to reduce the temperature before harvesting to initiate this natural transition into suspended animation, which provides a more humane end to a life-cycle than what is usual with large farm animals.

The more I learned about edible insects, the more often I returned to one question: how is it possible that this highly sustainable and ethical source of protein is not as widespread as meat? To find an answer, I teamed up with Daniel in 2016 to start a company called SENS Foods. Our plan was to put cricket-flour products on the shelves of big European retailers and make insects the new normal.
Very early on we realised that finding a reliable supplier of high-quality cricket flour would be one of our key issues. This is where Nicolas Bery came in.

Nicolas had become a regular guest speaker at various conferences, including the main insect conference, Insects to Feed the World, which was

held in Wuhan, China in 2018. We found each other in 2017, when he was testing his hypothesis in the form of a small-scale farming operation called EIF. The idea of building a large-scale, technology-driven cricket farm made a lot of sense to all of us. Nicolas had the know-how and ambition to elevate the insect-farming industry and we had a growing number of SENS protein bar and protein bread customers, and so the Cricket Lab was born, with Nicolas as CEO.

The farm itself operates in a large metal building next to a highway on the outskirts of Chiang Mai, Thailand, with a production capacity of 14 tonnes of crickets per month. Thailand has a long and deep tradition of farming crickets, and its climate provides optimal temperatures for cricket rearing – usually around 30°C.

A cricket farm of this size was also a way to solve one of the major obstacles for the widespread adoption of edible insects as food – price. Cricket Lab has set itself the goal of making cricket protein cheaper than chicken. Achieving this goal is a monumental task, even with the largest cricket farm in the world at our disposal. "There has been exactly zero research on large-scale cricket farming, while the costs are already competitive with animal protein. Over 80 years of research on poultry farming has brought about a sharp decline in costs. This is where I see the potential for crickets. They're just much more sustainable and ethical." says Nicolas.

A 2015 study by Lundy and Parrella published in PLOS One demonstrated how cricket farming could look. In an experimental setting, crickets converted 1kg of poultry feed into 588g of edible weight; compared to chicken, which generally only produces 416g from the same feed, crickets are the obvious efficient choice. The Cricket Lab was built to realise that potential. "The focus of our farming R&D is to maximise the output of crickets per square metre,"

> *"Insects do not have nociceptors, nerves that transmit pain"*

ABOUT THE AUTHOR

BEFORE CRICKET Lab and SENS Radek Hušek successfully founded and sold a start-up during his time at university. Having turned down a place at the London School of Economics, he concentrates today on making his dream of affordable insect nutrition come true.

Nicolas explains. Crickets are farmed in blue boxes typical to Cricket Lab. Each contains paper cartons to maximise the surface area for crawling for over 10,000 crickets. The boxes are vertically stacked in tailor-made racks, six metres high.

The room is humming from millions of crickets, as well as ventilators, which automatically regulate the environment. "The setup of blue boxes, light, temperature, humidity, ventilation, how much and how often to feed and water... those are the key variables for our research. Recently, we have achieved a 400 per cent increase in yield per square metre," says Nicolas. The square-metre output is crucial to the price of cricket flour, because many of the costs per box, such as utilities or human labour, remain fixed, regardless of cricket population.

According to the FAO, insects can be fed agricultural by-products that would normally be discarded. Crickets are perfect converters of low-value waste to high-value protein. On top of that, the by-product of insect rearing, frass, consisting of excrement and shed exoskeletons, can be used as an organic fertiliser and a natural biopesticide. Additionally, chitin and chitosan, two types of fibre found in insect exoskeletons, have a wide spectrum of uses in medicine, cosmetics, textiles and the food industry. "Our own cricket feed is crucial. Crickets can grow faster and bigger. The feed can come from organic by-products, thus making the final price of protein lower. It's a circular economy, in essence." Says Nicolas. This will be the research focus of the next investment round. Cricket Lab is currently raising a single-digit million USD investment to focus more on research and development, with the aim of reducing the costs of cricket flour.

The quality of feed is also a big factor for the nutritional composition of the final product. Based on what we are seeing in early nutritional lab tests, we are dealing with the most nutrient-dense cricket flour so far. It contains more than 65 percent protein, with a very similar amino acid ratio and digestibility to beef. It also carries notable amounts of vitamin B12, heme-iron, and omega-3 fatty acids. These nutrients are commonly found in meat but lacking in plants.

Various producers are adding cricket flour, which, crucially has a neutral flavour, to protein bars, bread, or pasta – items that easily disguise the insects and facilitate a positive first experience. Many startups, such as Exo in the US or our own SENS in Europe, are successfully selling such products to the more innovative segment of consumers. We will have to wait and see if crickets, or other insects, really catch on in the mainstream.

HPLC 2019

MILAN ITALY 16-20 JUNE 2019

The 48th International Symposium on High Performance Liquid Phase Separations and Related Techniques – HPLC 2019 Milan.

HPLC 2019 will cover fundamental, practical aspects of Separation Science, with particular emphasis on new hot topics in the fields of:

- hyphenated techniques
- design and characterisation of stationary phases
- micro- and nano-fluidics
- supercritical fluid chromatography
- capillary electrophoresis

and their applications in proteomics, metabolomics, food analysis, characterisation of biopharmaceuticals and biosimilars.

HPLC for process analytical technology (PAT), quality assessment and HP-TLC will also be featured during the Symposium.

We currently have **80 Keynote Speakers**, with 16 Short Courses scheduled.

Deadline for poster presentations is **20 May** (note: to be considered for Best Poster Award, abstracts must be sent by **29 April**)

Active participation of younger scientists is one of the main goals of HPLC 2019. To this end the event offers very low fees for students, plus special packages to participate in short courses, travel grants and two brand-new contests that will be presented in Milan for the first time in the history of the HPLC Symposia: the **Separation Science Slam** and the **HPLC Tube**.

Separation Science Slam is a competition where young scientists are invited to present their activities related to liquid chromatography workflow (before, during or after). Six finalists will present their projects in a dedicated Separation Science Slam session on 18 June.

No papers or abstracts are required from those wishing to take part in **HPLC Tube** but applicants are required to submit a video, in which they answer the question: 'How is your chromatography making a difference in the world?'. From these videos, an international Jury will select the nominees for HPLC Tube final round, which is scheduled to take place 19 June. Deadline for application is **30 April, 2019**.

Winners of both contests will be rewarded **with generous monetary prizes!**

Besides a rich scientific programme, HPLC2019 Milan will offer exciting social events. The gorgeous Conservatorio di Milano 'Giuseppe Verdi', the largest music academy in Italy, will be the setting for the **Opening Ceremony** on 16 June. **Professor Emeritus Martin Kemp** from Oxford University will delight the audience with a lecture on Leonardo da Vinci, marking the 500th anniversary of the polymath's death, accompanied by young musicians from the Conservatorio. The **Gala Dinner**, on 19 June, at the Central Courtyard of the Università degli Studi di Milano, a wonderful garden surrounded by neoclassical columns, will bring the spirit of the old Milano alive.

Stay connected via facebook, twitter and instagram for the latest news, updates and more!

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GMO Labelling Requirements

On 13 March, Daniel Smieszek, Analytical Expert in Microbiology and Molecular Biology, Nestlé, offered webinar participants, 'A deep dive into GMO detection using RTi PCR Methods.'

WHILE INTERNATIONAL food trade is growing worldwide, the authorities in each country are setting more and more regulations to ensure food safety and transparency for consumers. Across the world, Genetically Modified Organism (GMO) labelling is regulated in many countries. The United States will be joining the rest of world with GMO labelling regulation from January 2020. This new regulation supports US consumers, who are requesting more transparency and traceability on food-manufactured products.

The expansion of GMO crops globally, new regulatory requirements and consumer demand for choice and transparency increases the need for reliable GMO testing. A solution that can screen, identify and quantify GMO crops to ensure a proper control is required to provide accurate results, thus meeting regulation, labelling and consumer expectations.

Real-time polymerase chain reaction (PCR) is the most recognised tool for detection of GMO DNA sequences and recommended by Codex Alimentarious, ISO & EU reference laboratory for GM food and feed.

Daniel's webinar examined the evolving world of GMOs and looked at a three-step testing strategy using real-time PCR techniques to meet labelling regulations.

He offered background info on GMOs and where they can be found today, an overview on worldwide GMO labelling regulation and various GMO crops, and an update on the new US standard for GMO labelling, published on 20 Dec 2018. He also outlined the strategy using real-time PCR methods for GMO management and looked at its limitations. He discussed challenges posed in screening raw materials and finished products and, following the webinar, he answered a number of questions from participants.

The webinar is now available to listen to online, so to hear it in its entirety, along with questions and answers, log on now.

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When is a **bilberry** not a **bilberry?**

The acknowledged health benefits of berries are prompting increasing demand for bilberries and blueberries. But not all blue-coloured berries are the same – and that's why it pays to be aware of the differences, as *Tomi Helin* explains.

PROTEIN-RICH diets based on plant sources have become a hot topic, and demand for local food is on the rise. Common to these trends is a consumer interest in natural, simple, minimally-processed and organic products. These developments underscore the current need for better transparency in the production chain, from source traceability to clearer package labelling. 'Clean label' and 'Free from' statements are fast becoming the norm on food shelves across the globe, although common definitions of these labels have yet to be established. In addition, sustainability, transparency and corporate responsibility – aspects also associated with a healthy lifestyle – continue to gain attention.[1]

'Superfruits' are now considered an integral part of healthy eating. These health beneficial nutrient-rich fruits and berries have a high fibre, antioxidant, mineral or vitamin content, or a desirable fatty acid composition. Launches of new superfruit-containing products began to rise in 2008, and a huge 202 percent increase was seen between 2011 and 2015.[2]

Berries, or berry fruits, contain more vitamins, minerals, trace elements and polyphenols than many other fruits.[3] Interest in blueberries, which are widely used in commercial products, has increased along with superfruits, and blueberry-containing product launches have continuously increased worldwide over the last ten years (***Figure 1***).

Bilberry or blueberry?

Vaccinium (Ericaceae family) is a diverse genus of some 450–500 species, including more than 140 predominantly circumpolar species. Many have been traditionally used for food and are of economic significance today. Of the blue-coloured *Vaccinium* berries, the following three main groups are of industrial importance:

- Bilberry (*V. myrtillus*) is a wild growing shrub native to North Europe, Asia and Western parts of North America including the USA and Canada[4] and is commercially mainly sourced from Nordic countries and Eastern Europe.[5]
- Low-bush blueberry (*V. angustifolium*) is a native in Eastern and Central Canada and in the North-eastern United States.
- High-bush blueberry (*V. corymbosum*) is native to North America, Eastern Canada and the Eastern United States.
- Both *V. angustifolium* and *V. corymbosum* are utilised from wild picking, but for commercial purposes these berries are domesticated.[6] The key differences between these species are discussed here.[7]

BELOW: Number of blueberry-containing product launches have been increasing worldwide since 2007. (Mintel 2017)

FIGURE 1

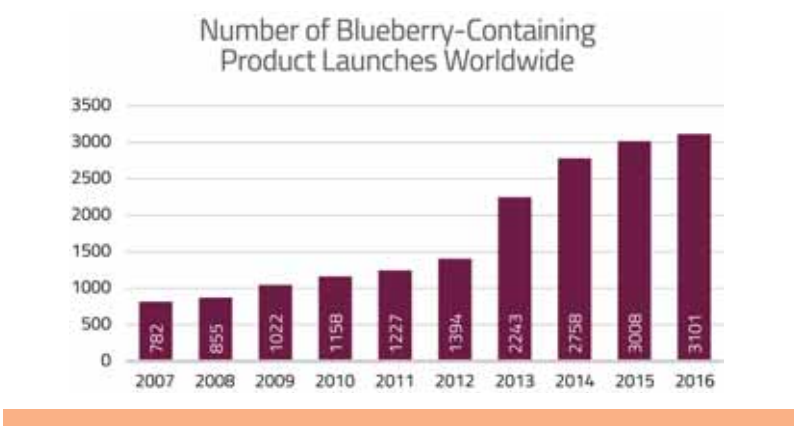


FIGURE 2

RIGHT: Key differences between bilberry and blueberry fruits and shrubs. Top: Anthocyanin-rich bilberry (*V. myrtillus L.*) fruits are dark blue throughout and grow individually (Arktiset Aromit 2018, [3]). Bottom: Blueberries (*V. angustifolium, V. corymbosum* and similar) have white flesh, a lower anthocyanin content, and grow in clusters (bilberry and blueberry cross-section Arktiset Aromit 2018, [3]; blueberry photograph at far-right courtesy of Hoppula 2019).

The health benefits of bilberry and blueberry, particularly with regard to cardiovascular diseases, diabetes, memory disorders and eye health, are well documented. The majority of this research has, however, focused on blueberry, and only relatively few publications specific to bilberry are available to date. The health benefits of, and thus economic and research interest in, blueberries and bilberries are based on their high flavonoid and anthocyanin content.[8]

Are there any differences?

To the untrained observer, blueberries and bilberries can look quite similar and both consumers and the food industry frequently make no distinction between them. On closer examination, however, significant differences quickly become evident. The various common names used for the berries – such as 'blueberry' and 'wild blueberry' – can, however, also be misleading, as they have different local meanings and are often used interchangeably, as presented in ***Table 1***.

In contrast to the widely cultivated blueberries (*V. angustifolium* and *V. corymbosum*), bilberries (*V. myrtillus*) only grow in the wild and are not obtained from cultivation. Bilberries are also smaller in size, grow individually on the shrub and are hand-picked, compared to blueberries, which are much bigger and grow in clusters, making the cultivated varieties easier and cheaper to pick mechanically. Another important difference between bilberries and blueberries is their anthocyanin content. The skin and flesh of highly anthocyanin-rich bilberries are both dark blue, compared to less anthocyanin-rich blueberries, which are white inside. The main differences in appearance between blueberries and bilberries are presented in ***Figure 2***, and further comparison of their key characteristics is presented in ***Table 2***.

The anthocyanin content of bilberries is not only significantly higher than both wild and cultivated blueberries, but also than many other berries and fruits. Demand for anthocyanin-rich bilberry is therefore huge in the food and food supplement industries. The superfruit status of bilberries and their superior health benefits make them a highly valued raw material. As a wild-harvested berry, however, bilberry is more sensitive to crop yield variations than cultivated berries and its price is accordingly higher. These factors collectively increase the vulnerability of bilberry products to falsification.

TABLE 1 **Examples of multiple common names of blueberries and bilberries (Gafner 2016; Foster S & Blumenthal M, 2012; Arktiset Aromit 2018,[3] p. 2-8)**

Latin name	Common name
- *V. angustifolium*	wild blueberry, wild lowbush blueberry, Canadian lowbush blueberry
- *V. corymbosum*	highbush blueberry, northern highbush blueberry, blue huckleberry, tall huckleberry, swamp huckleberry, swamp blueberry
- *V. myrtillus L.*	bilberry, European blueberry, common bilberry, blue whortleberry, huckleberry, artic bilberry

Bilberry adulteration

Due to the strong, growing demand and relatively high cost of bilberry, the risk of adulteration of bilberry products is high. With whole berries the main risk is the inclusion of other berry species. This can occur either purposefully by mixing in lower-cost berries, such as crowberry (*Empetrum nigrum*), or unintentionally due to a lack of knowledge and quality awareness among pickers and processors. In addition, an incoherent delivery chain from forest-to-factory reduces the traceability of wild-harvested berries. Operators can, however, mitigate these threats by ensuring supply chain transparency and strict quality control.

When moving from whole berries to processed products, the risks increase. Bilberries are widely used in food supplements and numerous cases of adulteration have been reported. In bilberry extracts, in particular, any relatively anthocyanin-rich fruit can be a potential adulterant or a lower-cost substitute for bilberry.[9] Common examples include other Vaccinium species, crowberry (*E. nigrum*), chokeberry (*Aronia melanocarpa*), blackcurrant (*Ribes nigrum*), black soybean hull, black rice and mulberry species. Use of food colourings, such as amaranth dye (FD&C Red 2, E 123) has also been reported.[10] As mentioned previously (***Table 2***), the variety of common names used for the different berries can confuse both the industry and consumers. In addition, 'homemade Chinese bilberry extract' and 'Chinese domestic bilberry extract' have been reported in some cases to be made from lingonberry and bog bilberry.[11]

Arctic bilberry is highly valued for its nutritional properties (anthocyanins) and natural, clean-growing environment. These aspects make arctic bilberry a very attractive raw material.

TABLE 2 **Comparison of key characteristics of bilberry and blueberry (Arktiset Aromit 2018, 2; Arktiset Aromit 2018, [3], p. 6-11)**

	Bilberry (*V. myrtillus L.*)	Blueberries (*V. angustifolium, V. corymbosum* and others)
Grow	Wild, forest No fertilizers, no pesticides	Cultivated and wild; mainly Canada/USA Fertilizers and pesticides may be used
Berries	Skin and flesh dark blue throughout Single berries Smaller in size, 6–8 mm	Skin dark blue, flesh mainly white Grow in clusters Large berries, wide variation in size
Picking	Hand picked	Often mechanically picked
Flavonoids and anthocyanins	Higher content	Smaller concentration compared to bilberry
Price	More expensive	

Unfortunately, not all bilberry products contain bilberries and not all packing identification is reliable. In a recent study of dietary supplements,[12] more than 30 percent of Vaccinium fruit (cranberry, lingonberry, bilberry and blueberry) products were found to not contain the fruit listed in the ingredients.

We conducted an online case study of bilberry products, together with the Finnish Arctic Flavours Association, in 2017.[13] In the study, the name, image and ingredients list on 98 bilberry products from different geographical locations were examined. In 59 cases (60 percent) the bilberry image on the package was accurate and correctly matched the listed ingredients. In 39 cases (40 percent) the product image and/or ingredient list contained contradictions. In many cases the product image did not represent bilberry at all but instead, for example, blueberry (*V. angustifolium*, *V. corymbosum*), blackcurrant (*R. nigrum*) or chokeberry (*Aronia melanocarpa*), or the ingredients list misleadingly declared bilberry as Vaccinium vitis-idaea *L* (lingonberry) or *Vaccinium uliginosum* (bog bilberry). Our findings raise key questions regarding the authenticity of berry products, especially in the case of highly processed goods.

Analysing berry authenticity

The risk of raw material adulteration is less with whole berries than ready-processed end products. Mixed in cheaper berry material can be difficult to detect organoleptically (by taste, sight, smell or touch), for example in juices, and requires specific analytical methods. The methods available to detect the adulteration of bilberry and other berry products are based on specific anthocyanin or metabolomic fingerprints. These include, for example, high-performance thin layer chromatography (HPTLC), high-performance liquid chromatography (HPLC), ultraviolet/visible (UV/Vis) spectroscopy, mass spectrometric (MS) detection, and metabolomic fingerprinting.[14]

In conclusion

Bilberries and blueberries, despite being separate species with different characteristics, are somewhat similar in appearance and therefore often confused with each other. Closer examination, however, reveals significant differences between them. Positive health responses have been proven for both blueberries and bilberries and both are recommended constituents of a healthy diet. The much higher anthocyanin content and purity of wild arctic bilberries, however, make them more highly valued on the market. From an industrial point of view, the mixing of cheaper blueberries or other dark-coloured berries with bilberries must be clearly started on package labels, given that using lower cost substitutes for bilberries can be an attractive way to save costs for manufacturers. The raw materials used in industrial tenders should also be marked. If the raw materials used are not correctly stated there is a risk that consumers do not know what berries have really been used.

Existing package labelling practices lack coherence and in many cases are intentionally misleading. In the case of processed end products, it can be difficult to differentiate blueberries and bilberries and the risk of raw material adulteration is therefore high. Raw materials used should be clearly and accurately named on the package label. This would be advantageous not only for industrial operators but also for consumers. The use of systematic analytical methods to detect authentic berries would also be beneficial to the whole industry.

The lack of a universal nomenclature for blue-coloured berries also presents a challenge. In particular, the terms blueberry, wild blueberry and bilberry are frequently used interchangeably for different species and confusions occur. For clarification, the common name 'bilberry' or, in the case of berries sourced from or in close proximity to the Arctic region, the name 'wild arctic bilberry', as well as, in both cases, the correct Latin name *Vaccinium myrtillus* should be used on product packaging. If other blue-coloured berries are used, they should be correctly and clearly specified on the product package.

ABOUT THE AUTHOR

TOMI HELIN is materials manager at dairy company Valio, Finland's biggest food exporter. With net sales of EUR 1.7 billion Valio products are found in some 60 countries and account for 25 percent of Finland's total food exports.

REFERENCES

To view references, please visit: **newfoodmagazine.com/2-19-Helin**

Vitafoods Europe

7-19 MAY, 2019

GENEVA, SWITZERLAND

Guiding the industry to a more sustainable future

As environmental awareness reaches new heights and the world's population continues to rise, the issue of providing sustainable foods that also offer a high nutritional value is set to grow, in both importance and complexity, over the next decade.

IT IS WITH these considerations in mind that Vitafoods Europe 2019 has developed its agenda. The three-day event will this year focus on bringing the industry together to discuss key challenges such as sustainable sourcing, and wider trends including free-from, plant-based ingredients, and hemp extracts and CBD.

This year's show is expected to attract 22,000 visitors and will play host to over 1,200 leading global suppliers active in ingredients and raw materials; dietary supplements; contract manufacturing and private label; and services and equipment, exhibiting thousands of quality ingredients and products.

As a meeting point for the nutraceutical industry, Vitafoods Europe 2019 will offer visitors an opportunity to source innovative, high quality ingredients and finished products conveniently at one location, saving both time and resources, and eliminating logistic difficulties.

The event has also added to its portfolio and introduced a range of new features, including a brand-new **Sustainability Square**, which will showcase the latest consumer and market insights from across the industry, allowing visitors to make informed and future-focused buying decisions.

To clear-up any confusion around updated or newly introduced EU and global regulations, Vitafoods has invited experts from the European Federation of Associations of Health Products Manufacturers (EHPM), who will be offering one-to-one consultations as part of a new **Regulatory Clinic**.

While a new **Clinical Trials Zone** will offer a step-by-step guide to the clinical trial process, a Diversity & Inclusion Roundtable will open the discussion on the importance of establishing diversity in the workforce to create an inclusive environment and the benefits this will bring.

Additionally, the **Vitafoods Education Programme** will return this year with a new flexible structure, giving delegates the chance to attend specific sessions, individual days or the full three-day agenda. Running throughout the event the programme will have 11 summits and over 50 industry and business experts, to discuss and debate breakout trends and the industry's latest studies.

To give visitors the opportunity to network in a more relaxed setting, supplementary events are also taking place across the three days, including the Community Breakfast, **Diversity & Inclusion Roundtable**, Nutrition Capital Network's sixth annual European Investor Meeting, Good Manufacturing Practices (GMP) Training by EAS Consulting Group, NutraIngredients Awards, 5K Run and Yoga Wellness sessions.

Chris Lee, Managing Director, Global Health and Nutrition Network, Europe, at Informa Exhibitions, said: "Sustainability is a crucial influencer in the purchasing decision making process for consumers who are becoming more health and environmentally-conscious. This and the need to provide enough food supply for a growing population, has led us to identify the sustainability of the industry as a key concern and opportunity for the nutraceutical industry.

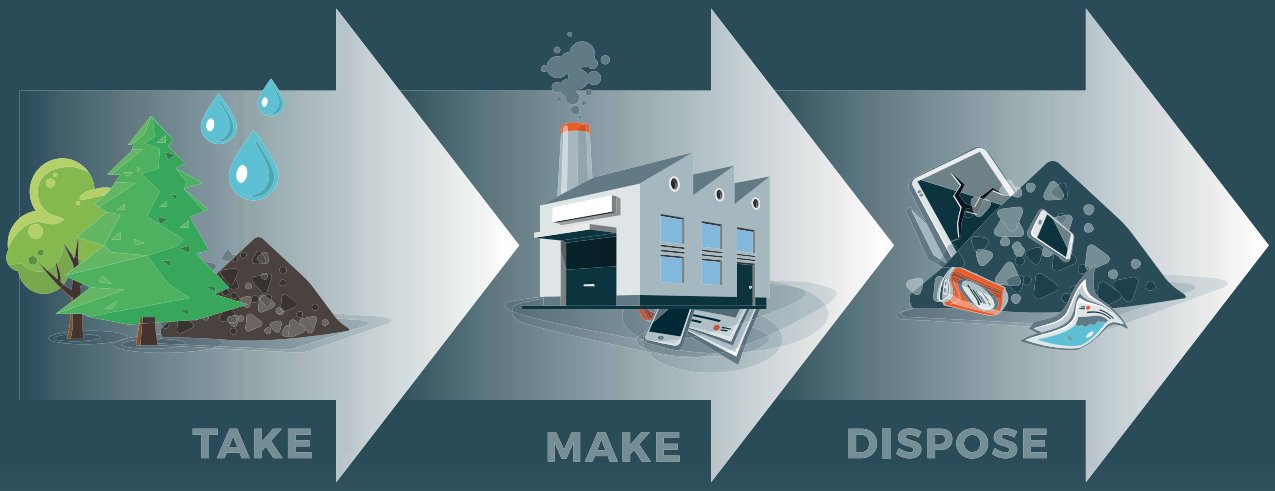
"Our goal with Vitafoods Europe 2019 is to bring the community together and open the discussion about the challenges and opportunities ahead. This way we hope to encourage collaboration across the entire nutraceutical industry and affect the move towards true circularity."

vitafoods.eu.com

PROCESSING

Academics Manoj Dora and Tez Padhee share their passion for investigating ways to facilitate a sustainable global food supply for future generations; highlighting how we can move from a linear to circular economy.

Martin Rose and colleagues from the Royal Society of Chemistry Food Group and Toxicology Group examine the facts, myths and perceptions surrounding naturals in food.



A **circular pathway** for the food **supply chain**

Manoj Dora and *Tez Padhee* share their passion for investigating ways to facilitate a sustainable global food supply for future generations; highlighting how we can move from a linear to circular economy.

ABOUT THE AUTHOR

DR MANOJ DORA is currently teaching at Brunel University London. He is passionate about food and the supply chain. He is persistently working on a fundamental societal challenge: reducing food waste and establishing a sustainable and food secured society. He has been involved in many capacity building initiatives focusing on food security worldwide and has disseminated in reputed fora such as TEDx and the University of Cambridge-Festival of Ideas.

THERE IS enough food produced today to adequately feed the global population, yet around 800 million people are undernourished, while two billion are overweight or obese. The cost of this damage to human health and the environment is far greater than the profits made by the farming industry. When food is wasted, so, too, are the resources, money and labour that go into producing it. According to WRAP (the Waste and Resources Action Programme), UK households generate 8.3 million metric tonnes of food and drink waste each year, valued at a minimum of $18.6 billion and responsible for about three percent of domestic greenhouse gas emissions. Similarly, about 150,000 tonnes of food is wasted in US households each day and more than 10 kilograms of food is wasted per person each month. Twenty percent of the food bought by the average American is never eaten; this amount alone could feed the 46 million Americans (ie, one in seven) who use food banks. If food waste was a country, it would be the third largest emitter of CO_2, after China and the US. Current food production and consumption habits have negatively impacted the environment – causing eutrophication and increased CO_2 emissions, as well as massive amounts of food waste. Food waste has serious consequences for the farming community, especially those smallholder farmers and their livelihood – 500 million of that community produce 80 percent of the food consumed in the developing world. Sadly, this inevitably affects the world's poorest and most malnourished people: nearly 80 percent of the world's poor live in rural areas and thus largely work in agriculture.

Half of the world's population is malnourished and hunger remains on the rise: one in three women is anaemic, and food insecurity is demonstrated in a rise in obesity.

The food sector currently accounts for approximately 30 percent of greenhouse gas

emissions and 70 percent of freshwater withdrawal. These statistics serve to illustrate the extent to which our modern-day food systems are riddled with inefficiency and ineffectiveness. Hunger is not necessarily a food problem; it's a logistics problem, it's a governance problem, it's a human problem.

So what's the solution?

There is growing consensus that the only way forward to ensure sustainable production and development is to switch from our current industrial 'linear' model to a circular economy (CE), offering tools to reduce the waste generated in the food chain. This includes the use of food by-products and waste, and nutrient recycling to establish an efficient and sustainable food supply chain. Our current model is linear – ie, take, make, use, dispose. We 'take' raw materials from the environment, 'make' something, 'use' or don't use it, and finally 'dispose'. For example: in a supermarket, food that is still good but needs to be removed from shelves – often due to inventory or overstock reasons – typically heads to the landfill. We need to adopt a new approach to avoid this wasteful situation that challenges economies across the globe. A circular approach – reuse, recycle, remake, redistribute – aims to ensure zero food waste in the food chain. For instance, misshapen or slightly blemished fruits and vegetables that don't meet the strict cosmetic requirements of supermarkets constitute a major part of the food waste problem, but can play an important role in circular economics. Retailers typically accept only about 60-80 percent of farmers' produce due to cosmetic reasons, so a system is needed that includes supportive organisations to make use of these rejected products.

Overcoming obstacles

There is a general lack of knowledge surrounding the opportunity cost of food waste across the supply chain, which could be integrated into a productive CE cycle. The opportunity cost in this scenario is the value of the best forsaken alternative. For instance, farmers do not have information about the opportunity cost of the food waste that goes to landfill, rather than being used for energy, compost or animal feed. Farmers would benefit from information regarding how to cost-effectively use, re-use or recycle food waste. Additionally, farmers need to identify and engage with other supply chain members to make best use of the resources. To establish synergistic collaborations where waste and by-products can be exchanged, sold or transferred, it is crucial to determine how stakeholders can work together and develop potential applications for unwanted materials.

An additional means of addressing the problem has centred on undertaking studies that focus on the demand-side aspects of sustainable consumption and end-consumer behaviours, such as food selection, physical flows and waste generation at household level.

There is a need to address sustainability issues from the supply-side of food chains by mapping food waste scenarios and potential by-product synergies in relation to farming, processing, and retailing. Moreover, we need to develop innovative business models that can incentivise food supply chain members to follow circular strategies. Directing food waste into a landfill is waste of a valuable resource. With appropriate technology and strategy, food waste can generate renewable energy, enhance the soil as a fertiliser, and feed animals.

A change of mindset

Eliminating food waste is economically plausible and can unleash new opportunities for businesses. We need to change our approach and start seeking more opportunities to reduce food waste. We must acknowledge that food waste is a lost economic opportunity and actively investigate where food waste may be occurring. We must help redesign the supply chain to enable it to better accommodate the re-integration of food that would otherwise be wasted into the production cycle. It's a responsibility for all food distributors, supermarkets, and importantly consumers.

> *"Hunger is not necessarily a food problem; it's a logistics problem, it's a governance problem, it's a human problem"*

ABOUT THE AUTHOR

TEZ PADHEE is a student at University of California San Diego, majoring in Mathematics and Economics. His research interests include Development Economics, Machine Learning and Circular Economy & Innovation. He is passionate about creating sustainable solutions for our world.

ABOVE: The number of undernourished people across the globe is estimated to number 800 million

Possible circular pathways for the food supply chain:

- Food waste could be used as a source of renewable energy and provide food producers an excellent source of energy for their production process
- Food waste could be used to produce bio-fertiliser; returning nutrients to the soil and as biofuel. It has been estimated that up to 90 percent of waste could be recycled. With these initiatives, industries could increase their profitability as well as sustainability credentials.
- Surplus food could be sent to charities, food donation partners and social enterprises for vulnerable and needy communities
- Employees could be given discounts on food that is on its last day of shelf life. This could be used as an additional incentive for the workforce and keep them motivated at work.
- Food waste could be a great source of animal feed for livestock.

BELOW: If food waste was a country, it would be the third largest emitter of CO2, after China and the US

There are significant developments, in both a technical as well as business-related sense, with potential to be applied in the food supply chain towards a circular pathway. The following are some examples of major advances:

Anaerobic digestion – a process of in-vessel treatment of waste is an innovative technology that has been developed in recent years. This technology provides a large-scale solution to organic waste and converts greenhouse gases such as methane into energy.

Waste to energy technology – such as gasification, pyrolysis, and plasma arc gasification have been developed in recent years and are being used by industry leaders.

Besides the technical advances, important business management practices have been introduced in sustainable business management. For instance, closed-loop supply chain and reverse logistics integrate components such as product design, performance measurement, and value recovery measures across the food value chain to manage waste efficiently. This encourages food supply chain members to contribute to a more sustainable economy by building waste reduction into design, and deliver improved customer satisfaction. Likewise, supply chain integration and collaboration among chain members in the food sector is an increasingly popular means of administering circular practices through information sharing and joint strategy development. Moreover, the Internet of Things and Big Data is playing a significant role in a circular economy through data-driven logistical planning.

Finally, a good understanding of the data and waste streams is vital to making decisions for establishing a circular economy. Hence, there is a need for more research, accurate measurement indicators and finally an easy-to-use practical tool kit for use by food supply chain members. Universities and research institutes will have to play a significant role in developing this area. Furthermore, training and appraisal for different stakeholders in circular economies can be vital tools and universities could provide such services to members.

By 2030 we will need two planets to meet the world's demands and by 2050, three planets! It's time to act. Finding solutions to provide nutritious food to nearly 10 billion people by 2050 without destroying our planet is one of the greatest challenges of our generation.

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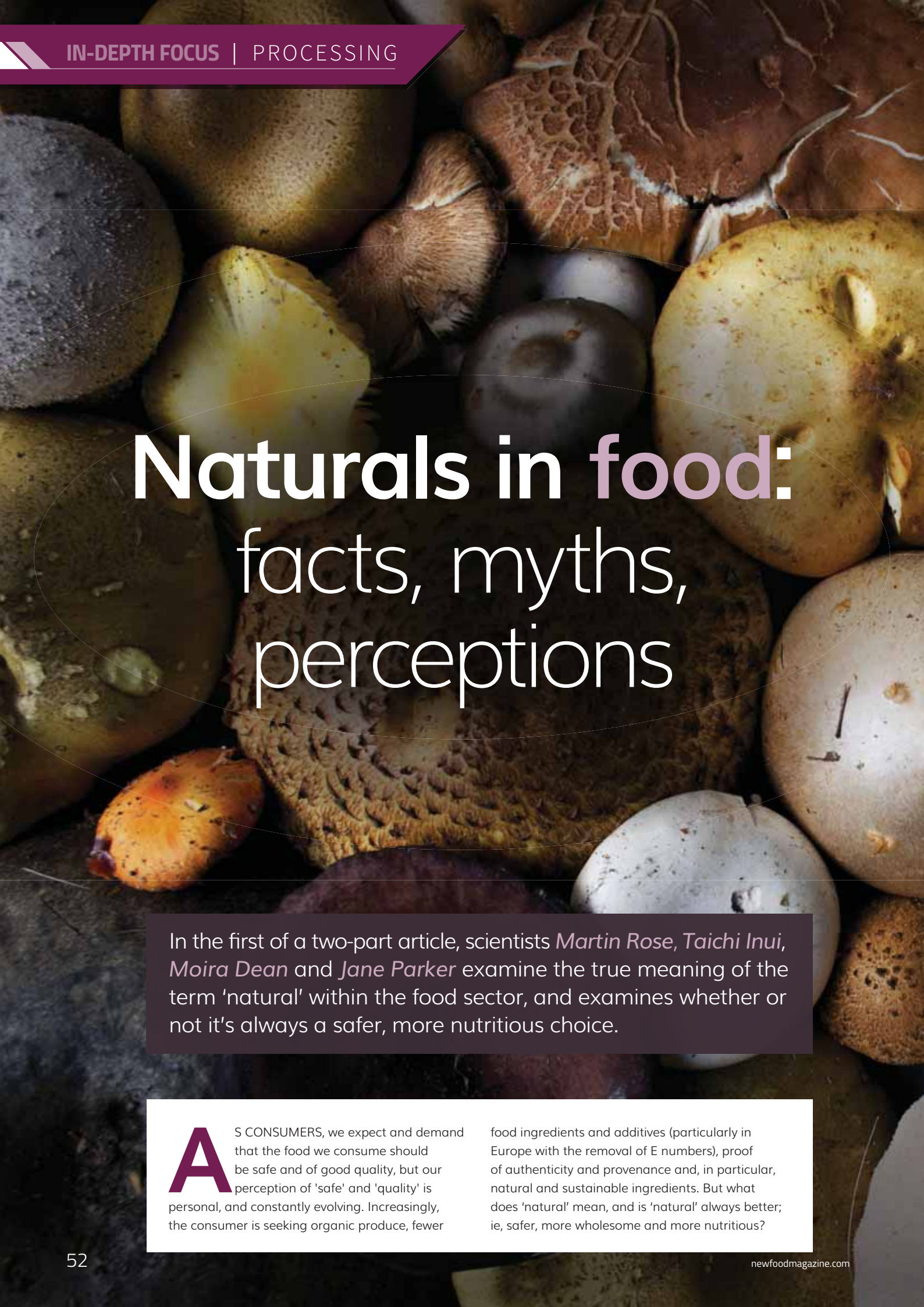
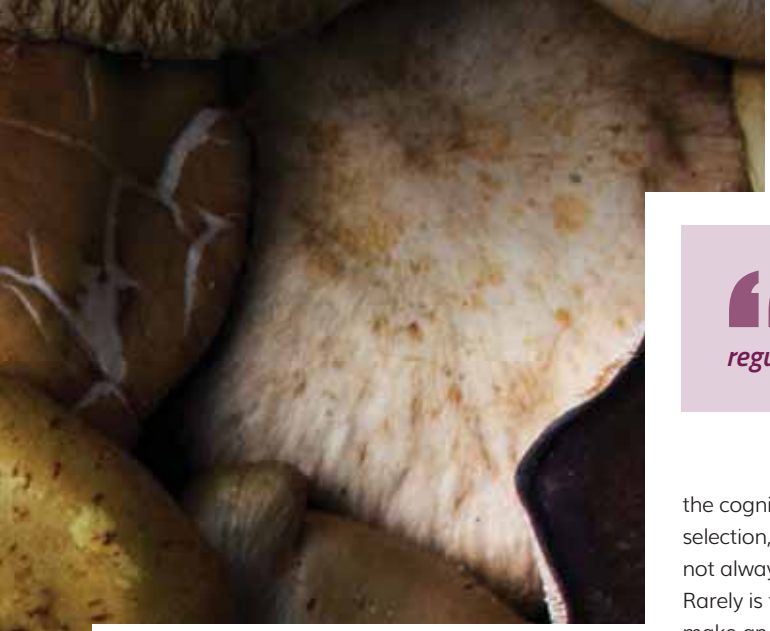


Naturals in food: facts, myths, perceptions

In the first of a two-part article, scientists *Martin Rose, Taichi Inui, Moira Dean* and *Jane Parker* examine the true meaning of the term 'natural' within the food sector, and examines whether or not it's always a safer, more nutritious choice.

AS CONSUMERS, we expect and demand that the food we consume should be safe and of good quality, but our perception of 'safe' and 'quality' is personal, and constantly evolving. Increasingly, the consumer is seeking organic produce, fewer food ingredients and additives (particularly in Europe with the removal of E numbers), proof of authenticity and provenance and, in particular, natural and sustainable ingredients. But what does 'natural' mean, and is 'natural' always better; ie, safer, more wholesome and more nutritious?



> *It is clear that the definition of 'natural' depends on your viewpoint – whether as consumers, as food regulators or as food chemists*

Are there times when transparency is compromised in order to be able to describe food as natural?

What is a 'natural' ingredient?

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

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

The distinction between these may be clear in the mind of the consumer, and is clear in terms of chemistry when considering clothing materials, for example, where natural (cotton) and synthetic (nylon) are quite distinctly different in their chemical make-up. However, the distinction is blurred when it comes to food, as in many cases the natural and the synthetic versions are identical chemically. In terms of risk, if the molecules are identical, neither the method of production, nor the origin are relevant. But even the consumer perception of 'natural' does not always mean safe; most recognise that some fungi can be dangerous, and are also aware of headlines such as "Two-star Michelin restaurant chef suspended over puffer fish poisoning"[1]. It is clear that the definition of 'natural' depends on your viewpoint – whether as consumers, as food regulators or as food chemists.

Consumer perception and consumer choice – heuristics

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

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

In contrast to the situation in Europe, the term 'natural' has no legal definition within the USA so consumers from the EU and the USA have a different perception of the term 'natural'. These different perspectives were discussed by Rosin *et al* (2012)[3]. In the USA, the most frequent definition of natural

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DR MARTIN ROSE has a background in analytical chemistry and worked as a Government research scientist in the field of food chemical safety for over 30 years. He is currently an independent consultant on food chemical risk assessment and food control. He is a member of the RSC Food and Toxicology Group Committees.

BELOW: Vanillin that has been synthesised from petrochemical precursors needs to be labelled differently to the identical molecule that has been extracted from Vanilla planifolia

RIGHT: Puffer fish may be a natural product – but that certainly doesn't mean they're always good for you; sometimes they can be poisonous.

ABOUT THE AUTHOR

DR TAICHI INUI holds PhD in natural products chemistry. He has expertise in nutritional science, preventive medicine, and food oral processing through 10 years industrial experience. Currently he is APAC Regional Manager for Nutrition Science & Advocacy at DSM Nutritional Products.

ABOUT THE AUTHOR

DR JANE K PARKER is a chemist, and a keen cook, who became fascinated with flavour – why and how do things smell? She is currently Associate Professor in Flavour Chemistry and Manager of the Flavour Centre at the University of Reading and a member of the RSC Food Group Committee.

was "no additives" whereas in Europe it was "lack of processing". Interestingly, "origin in nature" was only used by about one third of respondents, although in France and the UK, this figure was much lower.

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

RIGHT: In October 2018, the FDA announced that it was removing the 'natural' component of peppermint from the list of approved flavourings on the grounds that is it reported to be a carcinogen

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

Regulations

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

The flavouring regulations pose some interesting dichotomies. In the EU, flavourings are the subject of Regulation 1334/2008. Within these regulations, there are three guiding principles around the term 'natural'. These are that the origin of the source material must be natural, the flavouring substance must have been identified in nature and the material should be produced by 'traditional food preparation processes' as listed in Annex II of the regulation. Furthermore, these substances must meet the criteria that 1. they do not pose a safety risk to the consumer, and 2. their use does not mislead the consumer. At first glance, this seems entirely reasonable, but as is often the case with regulations, there are grey areas and anomalies. Firstly, note that the category of 'artificial' was not included in this regulation, so any claim in the EU for "no artificial flavours" is meaningless and illegal. Within the US, there are different definitions and natural flavourings must be derived from natural starting materials, and must also be listed as Generally Recognised As Safe (GRAS). ***Table 1*** shows just how diverse the flavour regulations are in the EU compared to the US. The US Food and Drug Administration (FDA) discourages the food industry from using the word 'natural' on labels because of its ambiguity. It accepts that it is a very complex term and have purposely decided not to define it on the grounds that, natural' may unjustifiably imply that a food is of superior quality or safety compared to other similar foods"[6]. In October 2018, the FDA announced that it was removing two 'natural' components of peppermint and sage (pulegone and thujone) from the list of approved flavourings, on the grounds that they are reported to be carcinogens, thus demonstrating their point that natural does not equal safe.

However, looking at vanillin we see the reverse, where vanillin which has been synthesised from petrochemical precursors (guaiacol and glyoxylic acid) needs to be labelled differently to the *identical* molecule that has been extracted from *Vanilla planifolia*. The legislation provides a clear distinction for consumers, although as chemists we see the same chemical just obtained from a different source (also see Part 2 in the next issue of *New Food* about 'natural' vanilla derived from non-vanilla sources). However, one key difference is that a compound from a synthetic source has undergone strict *in vitro* and *in vivo* toxicity tests, as required by EFSA, in order to be classed as flavouring substances. Another example would be that of smoke. Natural smoke contains polyaromatic hydrocarbons, which are known carcinogens, whereas these carcinogens can be removed (or omitted) from smoke flavourings. However, smoke flavourings cannot be labelled as natural.

ACKNOWLEDGEMENTS

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To find out more about the Royal Society of Chemistry (RSC), and in particular the Food and Toxicology Interest Groups, see https://www.rsc.org/Membership/Networking/InterestGroups/Food/index.asp and http://www.rsc.org/Membership/Networking/Interest-Groups/Toxicology/index.asp

The content and opinions in this article are the personal reflections of the authors and do not necessarily reflect the views of the RSC, the presenters, their employers, or any other organisation.

In the next of *New Food*, we'll be looking at risk assessment, and drivers and challenges in relation to 'natural' products and ingredients.

TABLE 1 **Natural status of flavour categories in the EU and the USA**

Flavour category	EU	USA/ROW
Flavouring substances	Can be natural	Can be natural
Flavouring preparations	Are natural	Are natural
Thermal process Flavourings	Can't be natural	Can be natural
Flavour Precursors	Can't be natural	Can be natural
Smoke flavourings	Can't be natural	Can be natural
Other flavourings	Can't be natural	Can be natural

ABOUT THE AUTHOR

PROFESSOR MOIRA DEAN'S research group focuses on studying the 'head, heart and hands' (perceptions, attitudes, and behaviours) of actors along the food supply chain to explore food security challenges in three main areas: (1) global food integrity, (2) nutrition and health, and (3) how we'll feed the world's growing population in a sustainable, cost-effective and environmentally friendly way

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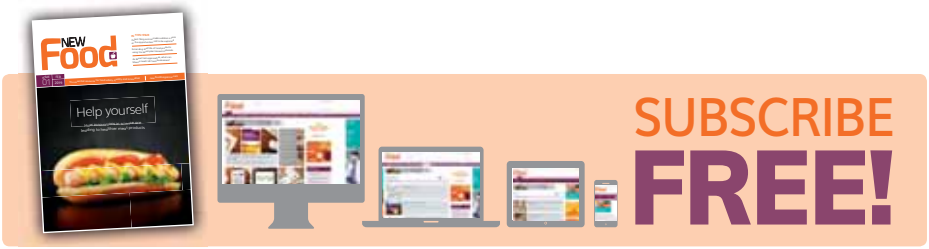

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The power of **Ceylon cinnamon**: more than just a spice

Hasitha Priyashantha and colleagues investigate existing and updated information regarding Ceylon cinnamon and its associated health benefits, with particular emphasis on how it compares with Cassia cinnamon.

ALTHOUGH the use of Ceylon cinnamon is not new, it has gained in popularity as an ingredient over recent years. While its phytochemical constituents such as phenolic and other bioactive compounds have seen it lauded for its health benefits, there are a whole host of additional claims surrounding the spice – almost as if cinnamon has magical properties. To separate fact from fiction and understand the scientific mechanism by which Ceylon cinnamon impacts human health, we have carefully examined many scientific articles and drawn our own conclusions.

History of cinnamon

Cinnamon has been used for culinary and medicinal purposes throughout world history, dating from ancient times to modern day. It is the earliest known spice to be associated with ancient rituals: the Egyptians used it in the mummification process, Romans believed it to be sacred, and many civilisations have employed its aromatic and cleansing properties. By the end of the middle ages, Europeans had come to learn about cinnamon from the far east and today it is used throughout the world, with particular association as a Christmas spice, used in many festive dishes. Currently, Sri Lanka has the monopoly in the world market (80-90 percent share) for Ceylon cinnamon.

Cinnamon cultivation

Cinnamon is a small, evergreen bush that is grown as a commercial plantation crop, under rain-fed conditions with occasional irrigation. A cinnamon bush can maintain and harvest continuously for up to 100 years, provided optimum conditions and management practices are adhered to. Plants are ready to harvest at a frequency of twice yearly, from 2.5 – 3 years after establishment. Stems in the harvestable stage are removed from the bush, after which time the shoots and soft outer bark is removed. Thereafter, the inner bark is peeled and sun-dried until it form curls.

Types of cinnamon

There are over 300 species in the genus *Cinnamomum* of family Lauraceae, including several important ones, which are used as spices. Common cinnamon species are: *Cinnamomum verum* (Ceylon cinnamon, also

known as true cinnamon and *Cinnamomum zeylanicum*) *Cinnamomum cassia* (cassia or Chinese cinnamon), *C. burmannii* (Indonesian cinnamon), *C. loureiroi* (Vietnamese cinnamon) and *C. citriodorum* (Malabar cinnamon). Chinese Cassia and Ceylon cinnamon are the most common commercial types. Although the name 'Cinnamon' accurately reflects Ceylon cinnamon, other species of the same genus are sometimes sold with the label 'cinnamon'.[1] The greater proportion of commercially available types of cinnamon in Europe are Cassia, probably due to its cheaper market price compared to that of Ceylon cinnamon.[2]

Nutritional facts about Ceylon cinnamon

The nutritional factors and composition vary depending on the region of cultivation, geographical origin and processing conditions. On average, dried Ceylon bark contains carbohydrates (59.5 percent), fibre (20.3 percent), moisture (9.9 percent), protein (4.6 percent), fat (2.2 percent), total ash (3.5 percent), calcium (1.6 percent), phosphorus (0.05 percent), and Vitamins A, B1, B2, C and niacin.[3]

What is Ceylon cinnamon and why is it unique?

Ceylon cinnamon is native to Sri Lanka (formerly known as Ceylon) and South India and has a characteristic slightly sweet flavour, distinct from cassia (see ***Table 1***).[2]

Cinnamon possesses a delicate balance of spicy aromatic volatiles: cinnamaldehdyde (75 percent) and eugenol (70 percent) are major components present in the bark and leaf, respectively.[5] Ceylon cinnamon essential oils contain cinnamaldehyde, benzaldehyde, cinnamyl acetate, limonene, and eugenol.[6] The composition and quality of essential oils vary according to cultivation techniques, soil conditions, harvest time, etc, but the major element of cinnamon essential oil is always cinnamaldehyde.

Essential oils have a wide variety of uses, including pharmaceutical, confectionery, perfumery, and in the food industry, where it is widely used for flavouring, seasoning and aroma enhancement. The culinary uses and sensory properties of cinnamon are relatively well known; however, the antioxidant, antifungal, and antibacterial qualities of cinnamon oil are a relative mystery. Thus, the following sections of this article focus on these reported benefits of Ceylon cinnamon.

Antioxidant and antimicrobial properties

Scientific investigations regarding the impact of cinnamon on food microbiological properties and on human health have intensified in the past decade. The antioxidant and antimicrobial properties of cinnamon lie in compounds that produce a physiological action on the human body: antioxidants. Antioxidants help our bodies to reduce oxidative stress, which is a type of damage to cells caused by free radicals, and which contributes to the development of many human diseases. The antioxidant and antimicrobial properties of cinnamon are largely due to the presence of bioactive compounds such as phenolics and terpens.

Antimicrobials are substances that kill or inhibit the growth of microorganisms such as bacteria. Cinnamaldehyde is the major component responsible for delivering antimicrobial properties[7], and Ceylon cinnamon has a particularly strong antimicrobial effect against 21 bacteria and four Candida species.[6] The highest levels of cinnamaldehyde (13.01-56.93mg/g) were found in Cassia cinnamon,[8] while Ceylon cinnamon bark oleoresin has shown to be completely effective in inhibiting fungal growth (*Aspergillus* spp) by demonstrating strong antifungal properties.[9]

TABLE 1 **The differences between Ceylon and Cassia cinnamon[4].**

	True / Ceylon cinnamon	Cassia
Visual difference		
Stick	Quill is contained with number of folders or layers and dense centers	Quill is contained only one inward folded and hollow centers
Texture	Less firm, thin and papery	More firm, rougher thick bark
Colour	Tan brown, light colour	Reddish dark brown
Aroma	Potent fragrance	Lightly fragrant
Taste	lighter, delicate and sweet taste	Stronger and hotter taste

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> *"Further research studies are needed to compare Ceylon cinnamon with other varieties, such as Cassia"*

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Besides the beneficial effects on human health, natural antioxidants and antimicrobial agents have become increasingly important additives in food processing. Lipid oxidation causes rancidity and the application of minute amount of Ceylon cinnamon have shown to preserve dairy foods,[10] meat[11] and bakery products.[12] The effectiveness of Ceylon cinnamon essential oils against lipid oxidation and microbial growth has been scientifically investigated,[13] proving to potentially extend the shelf-life of food products.[9]

Fight inflammation with cinnamon

Chronic inflammation can lead to long-term health problems, so the discovery that some natural compounds present in spices are potentially anti-inflammatory has led to increased research into cinnamon as a potential anti-inflammatory agent. Indeed, cinnamon was shown to suppress inflammation processes[14] and reduce levels of serum C-reactive protein, a biomarker of the inflammatory status.[15] Ceylon cinnamon essential oil represents a promising anti-inflammatory agent;[16] however, to clarify clinical efficacy, more research studies are needed.

Effects on gut microbiome, type 2 diabetes and cardiovascular disease

The human gastrointestinal tract, mainly the large intestine, harbours trillions of microorganisms collectively known as gut microbiota. Recent developments in gut microbiota research have uncovered that human health, wellbeing and diseases are linked with the gut microbiota; hence, gut microbiota serves as a new target for the prevention and treatment of many diseases. The food we eat contributes to the gut microbial composition that ultimately affects our health, and the inclusion of cinnamon in our diet seems to enhance the healthy microorganisms in the gut and improve the gut barrier function by fighting against pathogenic microorganisms.[17]

Diabetes is one of the major cause of deaths worldwide, causing blindness, kidney failure, heart attacks, stroke and necessitating lower-limb amputation. Type 2 diabetes results from the body's ineffective use of insulin, which is the hormone that regulates blood sugar and is usually associated with unhealthy diets, excess body weight and physical inactivity.[18] There is some evidence that cinnamon is useful in lessening appetite and thus lowering food intake and blood glucose levels.[19] Furthermore, cinnamon supplementation with 500mg capsules twice daily has been shown to positively influence anthropometric parameters, glycaemic indices, and lipid profiles of patients with type 2 diabetes.[20] By contrast, according to a systematic review, cinnamon intake did not have a positive effect on controlling type 1 or type 2 diabetes.[21] Some beneficial effects of Ceylon cinnamon from *in vivo* studies have been reported, including: a) attenuation of weight loss associated with diabetes, b) reduction of fasting blood glucose, c) reducing LDL and increasing HDL cholesterol, d) reducing HbA1c, and e) increasing circulating insulin levels. In addition, it has demonstrated beneficial effects against diabetic neuropathy and nephropathy.

Cardiovascular diseases are a huge public health threat and responsible for 17.9 million deaths globally every year.[22] A systematic review performed by European and Australian scientists on 13 randomised controlled trials with 750 patients revealed that cinnamon supplementation significantly reduced blood triglycerides and total cholesterol concentrations, yet had no effect on blood low-density lipoprotein (LDL) cholesterol and high-density lipoprotein (HDL) cholesterol (also referred to as healthy cholesterol) concentrations.[23] However, another study showed a significant increase in good HDL cholesterol after oral cinnamon supplementation in Asian Indians with metabolic syndrome.[24] A recent clinical study evaluated the pharmacodynamic properties of Ceylon cinnamon in healthy adults.[25] Consumption up to 500mg of water-extracted cinnamon for three months was reported as safe and demonstrated beneficial anti-hyperlipidaemic and blood-pressure-lowering effects among these subjects.

Available literature suggests that cinnamon may enhance the human gut microbiota and reduce

BELOW: A factory plantation of cinnamon trees and bushes – Sri Lanka is the world's largest producer of the spice

type 2 diabetes and cardiovascular diseases. Unfortunately, there is insufficient clinical data on cinnamon and gut microbiota or these diseases at present, hence thorough conclusions cannot easily be drawn.

Can cinnamon prevent Alzheimer's disense?

Some research groups have claimed that cinnamon is a potentially promising approach to prevent or hinder progression of Alzheimer's disease.[26] Indeed, cinnamon possesses neuroprotective effects and interferes with oxidative stress. In particular, cinnamaldehyde has proved to be an effective and safe approach to the treatment and prevention of Alzheimer's disease.[26] Scientists are also speculating as to whether or not coumarin in cinnamon has a role to play in Alzheimer's disease, as they are important acetylcholinesterase inhibitors. We should emphasise that there is currently no reliable scientific evidence to support this.

Potential adverse effects (toxic)

Food safety is of major concern to consumers, regulatory agencies and food industries and it is not yet known whether long-term consumption or higher doses of cinnamon are safe. Adverse events associated with cinnamon consumption have not been systematically studied; yet coumarin, which can be present in cinnamon in high amounts (indeed cinnamon has been identified as its main dietary source[1]), can be carcinogenic to humans. It possesses strong anticoagulant properties and can have potentially toxic effects on the liver. Most coumarin levels are not harmful to humans in the amounts present in plants, but the situation when transferred to food containing cinnamon is far from clear,[27] The coumarin content in Ceylon cinnamon is much lower than that of Cassia cinnamon.[28] Despite research studies proving a clear link between coumarin content and liver cancer in lab animals, the quantities used in food are small enough for it to remain safe for human consumption.[29] A German study showed there to be a higher coumarin content in those Cassia cinnamon powders available on the German market.[30] An Italian study, meawhile, showed that Cassia is more common in the Italian market than Ceylon cinnamon, where the name 'cinnamon' is concomitantly used to market both Cassia and Ceylon cinnamon.[1] A study in the Czech Republic reported that most cinnamon on the market is either Cassia, or composed of some portion of Cassia, and therefore contains higher levels of coumarin, ranging from 2,650 to 7,017 mg/kg.[2] Moreover, authors have compared market-available cinnamon with Ceylon cinnamon (sourced from Sri Lanka) and found the latter to be coumarin-free. The US Food and Drug Administration (FDA) has banned the use of coumarin as a food-flavouring agent.[31] In 1988, the Council of the European Communities set a maximum limit of 2mg/kg of coumarin in food and beverage products. Many cinnamon products available on the Italian market were found to exceed these maximum recommended levels.[1]

The key conclusion to draw is that it's important to use cinnamon safely, appreciating the differences between that used within a balanced nutritious diet and that used for complementary health benefits. Studies investigating the bioaccessibility and bioavailability of cinnamon and its constituents are still limited and further research studies are needed to compare Ceylon cinnamon with other varieties, such as Cassia.

Take-home message

Through careful analysis of the scientific literature, we consider that cinnamon – both Ceylon and other varieties – provides numerous health benefits, and is more than merely an aromatic spice. When used in small amounts, it is safe for most people. Ceylon cinnamon contains much lower levels of coumarin; consuming large amounts of Cassia cinnamon, on the other hand, might prove harmful. Cinnamon not only enhances the flavour and colour of food, but may eventually protect the human body from acute and chronic diseases. We say "eventually" because although many studies have identified potential benefits of cinnamon consumption, many of these studies have been animal or *in vitro* studies – no long-term experimental studies have been performed on humans. It's clear that high-quality trials in humans are needed to better understand the impact of cinnamon on food stability, safety and health.

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REFERENCES

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BELOW: Cinnamon is widely used in baked goods across Europe

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Application of NMR as a solution for detecting honey fraud

At QSI, NMR honey profiling is used routinely to detect honey adulteration, particularly the addition of sugar syrups – the most widespread form of honey fraud. Declared botanical variety and geographical origin can also be verified with this technique.

IN AN ENGAGING webinar that took place at the end of February, Gudrun Beckh (CEO at QSI) discussed how NMR is applied in routine analysis and the advantages it has to offer over other techniques. Traditional testing methods often struggle to detect new and sophisticated sugar syrups that have been designed to pass adulteration tests. With NMR profiling, a fingerprint of the sample is acquired, and many parameters are analysed simultaneously. The approaches applied for syrup detection verification were explained.

The simple sample preparation and fast measurement that NMR offers was described, as well as the wide range of information from the multiple parameters that can be acquired simultaneously. Bruker BioSpin Market Manager for Food, Feed and Beverage, Thomas Spengler introduced the NMR Food Screener used at QSI and discussed the robust background reference database.

Questions raised and discussed included:

- How NMR works and is applied as a tool for routine, daily analysis of honey
- The use of NMR spectral data to determine sugar adulteration without the need for confirmation by techniques
- The use of NMR for verification of the declared geographical and botanical varieties
- The advantages the methodology has to offer over conventional methods
- The background reference database that ensures complete reliability
- How NMR is a powerful method for combating the dynamic nature of food fraud.

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