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The Column

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Improving food safety

— the role of speciality gases

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Sophisticated Measures to Ensure Food Safety and Integrity

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In February this year China announced intensified efforts to ensure safer food, after melamine-tainted milk products from the 2008 scandal in which six babies died and 300000 babies fell ill, re-emerged in several stores around the country.

This tragedy brought the issue of food safety under the world spotlight. The World Health Organization (WHO) has stated that foodborne diseases and threats to food safety constitute a growing public health problem. Unsafe food is the cause of many acute and lifelong diseases, ranging from diarrhoea diseases to various forms of cancer. WHO estimates that foodborne and waterborne diarrhoeal diseases taken together kill about 2.2 million people annually, 1.9 million of them children.

Many world governments, particularly those in developed countries, have established dedicated bodies to develop, monitor and enforce food safety directives and regulations.

The EU parliament is informed on food safety matters by the European Food Safety Authority (EFSA). In the US, the Food and Drug Administration (FDA) publishes the Food Code, a model set of guidelines and procedures that assists food control jurisdictions by providing a scientifically sound technical and legal basis for regulating the retail and food service industries, including restaurants, grocery stores and institutional foodservice providers such as nursing homes.

In recent years, the Chinese government attempted to consolidate food regulation with the formation of the State Food and Drug Administration of China in 2003 and, following the 2008 tainted milk scandal, officials have come under intense public and international pressure to solve food safety problems. However, it appears that these regulations are not well known by the trade. Labels used for "green" food, "organic" food and "pollution-free" food are not well recognized by traders and many are unclear about their meaning.

Pathogens and Fungus

As little as 20 years ago, three of the four most significant foodborne pathogens — *Campylobacter, Listeria* and *enterohaemorrhagic E. coli* (EHEC) — were unrecognized as causes of foodborne illness.

Campylobacter jejuni is today regarded as the biggest cause of foodborne infection in the western world. For example, scientists believe that contaminated bottled water could account for 12% of infections by this bacterium. *Listeria monocytogenes* (Lm) is regarded as emerging because the role of food in its transmission has only recently been recognized. In pregnant women, infections with Lm can cause abortion and stillbirth, and in infants and people with a weakened immune system, it may lead to septicaemia and meningitis. *Escherichia coli* serotype O157:H7 (E. coli) has rapidly emerged as a major cause of bloody diarrhoea and acute renal failure.

Mycotoxins are toxic chemical products formed by mould species including *Penicillium*, *Aspergillus* and *Fusarium*. These moulds can readily colonize food crops such as cereal grains, nuts and fruits, either in the field or post harvest. Consumption of foods produced from these commodities poses a potential risk to human health because the toxins are resistant to various food processes, including heat treatment. Mycotoxins rarely cause acute illness in developed countries but long-term consumption of low levels has been linked to disease.

Microbiology laboratories doing classical testing use speciality gas mixtures containing carbon dioxide, hydrogen, nitrogen or oxygen to create aerobic and anaerobic controlled atmospheres in controlled temperature incubators to stimulate and control microbial sample growth that assists with the microbial analysis.

Contemporary Threats

In addition to these pathogens and fungi, there are a vast range of more contemporary health threats associated with the presence of pesticides, heavy metals, antibiotics and other food contaminants such as melamine.

In the recent Chinese melamine scandal previously referenced, several thousand babies became ill, having suffered acute kidney failure and there were several fatalities amongst them. The melamine was used because of its high nitrogen levels — 66% nitrogen by mass — that gives it the analytical characteristics of protein molecules that would naturally be occurring in milk.

More than a billion pounds of pesticides are used annually in the US alone to control weeds, insects and other organisms that threaten or undermine human activities. Although this is a necessary process, studies show that pesticides, which are toxic by design, can cause health problems, such as birth defects, nerve damage and cancer over a long period of time.

Together with essential nutrients, plants and animals also take up small amounts of contaminant heavy metal compounds and can concentrate them. This can be harmful as even minute quantities of certain heavy metals such as lead, cadmium and mercury are recognized to be potentially toxic when consumed by humans. Mercury exposure via food most often occurs when seafood containing mercury is consumed. Prolonged mercury ingestion may lead to serious health problems such as methylmercury poisoning, vision problems and neurological disturbances in foetuses and infants.

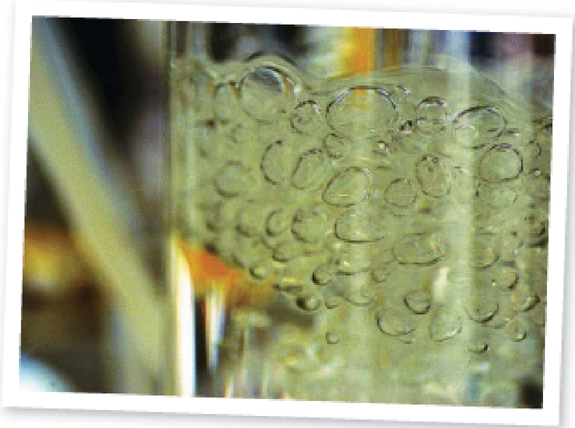
Antibiotics are routinely used to prevent disease among animals in conventional industrial farming but some modern industrial livestock operations also mix non-therapeutic antibiotics into livestock feed to stimulate animal growth and weight gain. In addition to the danger of consuming these and other veterinary drug residues, public concern in this regard focuses on the possibility of creating drug-resistant organisms.

All of these contemporary threats rely on accurate scientific analysis of food at various points in the supply chain to ensure safety and integrity.

Food Authenticity

The British Food Standards Agency defines food authenticity as a term that refers to whether the food purchased by the consumer matches its description. Misdescription can occur in many forms, from the undeclared addition of water or other cheaper materials, or the wrong declaration of the amount of a particular ingredient in the product, to making false statements about the source of ingredients (i.e., their geographic, plant or animal origin.) For example, French champagne should be French and an extra virgin olive oil should not be blended with cheaper components.

The Agency has initiated a Food Authenticity Research Programme that applies novel technology where possible to develop methods that can be used to check that foods are correctly described and labelled.



of the consumer. The father of modern day food science was Louis Pasteur, a French chemist and microbiologist who made remarkable breakthroughs in the causes and preventions of disease. He is best known to the general public for inventing a method to prevent milk and wine from causing sickness, a process that came to be called pasteurization.

There are a variety of different analytical techniques available to determine a particular property of a food material. The analytical technique selected depends on the property to be measured, the type of food to be analysed and the reason for performing the analysis. For example, targeted analysis is used when the particular compound is already known and needs to be quantified, whereas screening and identification techniques are used when the compound is unknown.

In the 21st century, principally four different types of laboratories conduct food analysis: "in-house" laboratories undertaking research and development, checking for contaminants and monitoring food quality at food manufacturers; commercial contract laboratories, which handle outsourced work from the in-house laboratories and are independent, often providing specialized

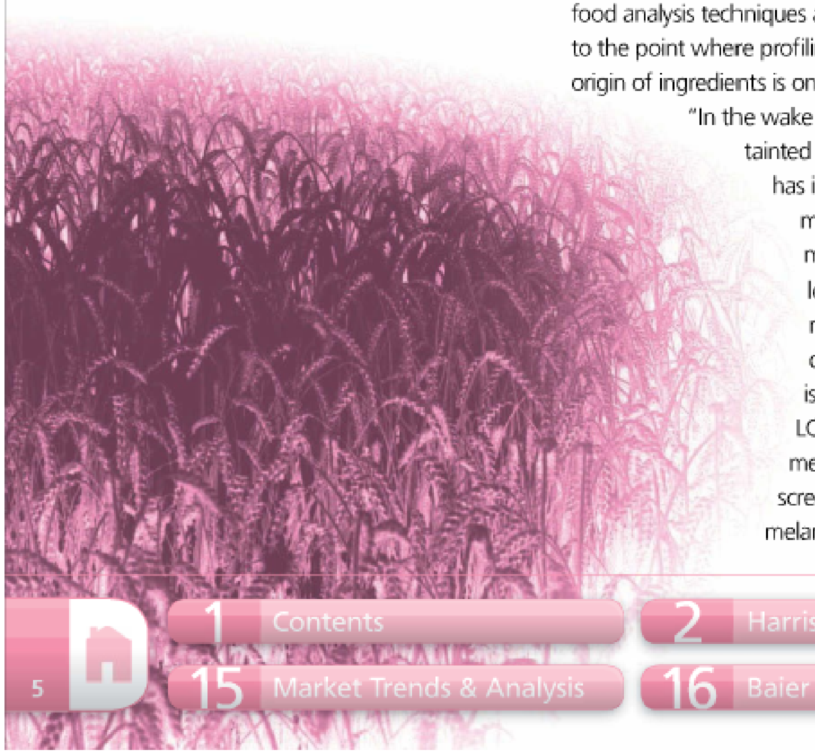
This helps to ensure that consumers are not receiving misleading information about the food that they eat.

Food Analysis

Food safety requires scientific monitoring to ensure the safe handling, preparation and storage of food. Quality and consistency are also primary outcomes in food production, which have driven the development of scientific food analysis methods and instrumentation to highly sophisticated levels.

Scientific methods of food analysis first emerged in the mid-19th century, when chemical and microscopal knowledge had advanced to a point where food substances could be analysed and the subject of food adulteration began to be studied from the standpoint of the rights and welfare expertise for niche analysis; academic research laboratories; and fourth, regulatory and compliance laboratories aligned with food safety authorities such as the FDA and the EFSA, which conduct investigations into food safety incidents. The latter use complementary techniques and they set food standards at government level. Much of their work is also outsourced to commercial or research laboratories.

Speciality gases are used for food analysis in laboratories around the world. Gases are also used with GC–MS and LC–MS systems to verify food ingredients such as sweeteners, colourings, aromas, the addition of glycerol, any undeclared additives, to identify isotopic profiles and to assess whether flavours are natural. Gases also play an important role in the assessment of fat content, whether a fat is saturated or unsaturated and in determination of the protein content. Additionally, gases assist with the very complex chemistry testing of olfactometry — the testing of flavour and smell compounds.



Sophisticated Analytical Techniques

"Today, sophisticated technology protects food consumers from risk of illness from contaminated foods," says Linde's Stephen Harrison, Global Head of Speciality Gases and Speciality Equipment. "Laws and regulations have tightened up considerably and scientific food analysis techniques are advancing rapidly to the point where profiling to determine the origin of ingredients is on the way."

"In the wake of the melamine-tainted milk incident, the FDA has instituted analytical methods to detect melamine levels as low as 0.25 parts per million (ppm). Analysis down to 0.25 ppm is made using LC–MS–MS. The GC–MS method is used for screening the presence of melamine and analogues. These sophisticated analytical techniques were developed by regulatory and compliance laboratories specifically to identify the presence of melamine and have now become a standard methodology. ICP-MS, used for trace element analysis, is also coming to the fore. These techniques require high purity speciality gases with very low levels of impurities," commented Harrison.

In verifying food ingredients for the absence of undeclared additives, laboratories also make use of atomic absorption spectrometry, which is a very fast and accurate way to screen for contaminants at levels as low as parts per billion, for example for the analysis of mercury in fish. Laboratories also monitor the authenticity of origin and for adulterations of natural product using nuclear magnetic resonance (NMR), which compares the food stuff with a known sample. NMR requires liquefied helium for its extremely cold property to activate the super-conductive magnets essential for this analytical technique.

Today it is a standard procedure for any food product entering the USA and Europe to be tested by independent laboratories. Many responsible food manufacturers also voluntarily send regular samples to these laboratories to verify their own findings. Occasionally a national authority will request a spot audit of a process if a potential issue or crisis is suspected.

Speciality Gases

"Food analysis represents a very important market and the demand for speciality gases that can facilitate the detection of ever lower levels of chemicals in food is on the increase," says Linde's Katrin Åkerlindh, Global Product Manager, Speciality Gases. "Linde has an extremely broad offer for the food industry. Many of these products support the integrity of food quality throughout the manufacturing and supply chain.

"For example, liquid nitrogen is used to protect the integrity of food by freezing and chilling food products, while sulphur dioxide is used for wine preservation. Another area is the supply of refrigerant gases for freezing and chilling of food while it is being transported from the manufacturer to the wholesaler or retail outlet, while Modified Atmosphere Packaging (MAP) gas mixtures protect food from deterioration, loss of flavour, loss of colour, microbial spoilage — and extend shelf life dramatically.

"It's critical to monitor food quality at a variety of different control points, from the supply of individual ingredients, through the manufacturing process and during distribution. For these purposes, Linde's HiQ laboratory nitrogen generators are ideal for use with mass spectrometers, while our combined hydrogen and air laboratory gas generator for gas chromatography is also ideally suited to food analysis," Åkerlindh says.

Complementing its HiQ speciality gases range, Linde's REDLINE gas supply system for high-purity gases and speciality gases is a modern, carefully designed range of regulators, panels, valves and gas control equipment.

"Distribution systems for high-purity speciality gases have to match up to increasing demands for high standards of performance, new analytical methods and production refinements," comments Åkerlindh. "Impurities occurring in just a few parts per million or parts per billion can have serious consequences. The demands made on regulators and valves in these environments are extremely high. Components must be capable of dealing with high and low pressures, large and small flows. They must be suitable for high-purity inert gases as well as reactive, flammable, corrosive or toxic gases. Our REDLINE product range meets these important criteria, based on our customers' experience and our own."

Stephen Harrison is a chartered chemical engineer, born and educated in the UK. He has worked in industrial gases for the past 20 years — initially in customer applications and technlogy in the UK and more recently in business and marketing for speciality gases globally. He now lives and works in Germany.
Katrin Åkerlindh has spent the last 12 years in speciality gases, speciality equipment and pharmaceutical grade gases for both Linde and prior to that AGA AB in Sweden. She has been focused on global business development, sales and marketing and project management. She also spent three years working in the pharmaceutical industry working with quality control, method validations and instrument qualifications. Åkerlindh holds a degree of MS in Chemical Engineering and an Executive MBA.

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