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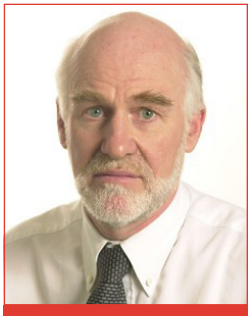
Analytical Challenges in Measuring Migration from Food Contact Materials



Professor John Gilbert, Director of FoodLife International, Ltd.

A growing array of novel packaging, preserving and handling materials have revolutionized the processing and marketing of food products. But many of the materials that come into contact with food contain additives and processing aids which can migrate into foods and create contamination. LCGC Magazine contributing Editor Fred Gebhart recently spoke with Professor John Gilbert, Director of FoodLife International Ltd., to discuss the increasingly sophisticated uses of mass spectrometry to monitor migration of materials from food packaging into food products.

LCGC: What are food contact materials?

Gilbert: By definition, a "food contact material" is any material that has been approved for food use. Most food contact materials tend to be used for packaging, but there's a huge range of articles such as cookware, spoons, spatulas, tableware, chopping boards, plus all the things that are used throughout the food chain.

LCGC: What are examples of typical food packaging materials and the challenges with possible contaminants?

Gilbert: Plastics are obvious, especially the polyolefins. HDPE, LDPE, polypropylene, PET, polystyrene and so forth are very typical plastics used in bottles, sheets, and film formats.

Films can involve multiple laminate layers that are stuck together with adhesive to achieve the desired physical properties. Sometimes they're printed on the outer surface as well. This complexity can give rise to analytical challenges, because you can get migration not only from the layer of the film in immediate contact with the food, but components of the adhesive can migrate into the food.

Coated paper and board are widely used. Problems can arise with the printing inks and adhesives. Even steel cans tend to be coated with a polymeric coating on the inner surface. Most packaging materials have had a history of some sort of contamination arising by migration.

LCGC: What sort of regulations govern the materials which come into contact with food?

Gilbert: The EU has a massive positive list. All starting substances, which for plastics would be monomers, and all additives are listed. You can only use an authorized substance from this list, and there are controls around each substance , including the amounts that are permitted to migrate into food.

In the US, each plastic formulation is separately authorized and licensed. Whether it's the US, or Europe, or Asia, the whole area is fairly tightly controlled and much of the analysis is driven by regulations.

LCGC: Which portfolio of analytical technologies is required to provide comprehensive targeted analysis of food packaging contaminants?

Gilbert: We're dealing with a diverse range of chemicals. We're dealing sometimes with very volatile substances, like vinyl chloride, acrylonitrile, vinylidene chloride, molecules that you can only do by headspace analysis.

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At the other end of the spectrum, we're dealing with very complex mixtures of higher molecular weight substances like mineral oils. We're dealing with things that are highly polar, extremely non-polar, classical metals that can leach from metal cookware and ceramics, and increasingly, metallic nanoparticles.

Almost everything that's in the analytical armory is involved in migration testing. Headspace GC-MS, LC-MS MS, LC high-resolution accurate mass, the Orbitrap instrument, atomic absorption, ICP-MS, even DART-Orbitrap MS. You name the analytical technique, it's being used in the packaging migration area.

LCGC: How important is non-targeted analysis and do you see a role for HRAM technology coupled to GC and LC in food contact material analysis?

Gilbert: We've developed statutory methods for targeted analysis because the regulations have tended, in the past, to be related to target analysis. The concept of Non-Intentionally Added Substances, NIAS, has been introduced into the EU regulations. These NIAS could be decomposition products, additives, oligomers, or adventitious contaminants. Producers now have a responsibility to show that they've done all they can to identify these non-intentionally added substances. And the only technique you can really use is based around full scan data, using high-resolution accurate mass. LC Orbitrap and, now GC Orbitrap, are the technologies we will see increasingly used in the non-target area and for packaging materials.

LCGC: Are analytical requirements becoming more complex with the increasing emphasis on the use of recycled materials?

Gilbert: I don't think that is the case because recycling is only conducted using authorized processes. In plastics, once the material has gone through the super cleaning recycling process, it should be indistinguishable from virgin material in composition and quality.

We have seen some issues with recycled paper and board that originated from the printing ink components that led to cross contamination. Some of these problems, cannot be anticipated and again, this is where non-targeted analysis will increasingly play a role.

LCGC: Does the introduction of active packaging and intelligent packaging provide new challenges?

Gilbert: Active packaging extends shelf life, things like moisture absorbers in meat packaging trays or the small sachets that scavenge ethylene or oxygen to modify the atmosphere of the packaging. We also see releasing systems, which might be a sachet slowly releasing an antimicrobial agent.

Intelligent packaging is more used to provide information for consumer on safety and quality of the food product like time/temperature indicators. I don't think there are many issues with intelligent packaging.

Issues are more likely to arise with active packaging and with nanoparticles. I recently saw a very nice example looking at silver nanoparticles incorporated into plastic chopping boards as an antimicrobial agent. Researchers looked at transferring silver nanoparticles into chicken meat. They used the Thermo Scientific XSERIES 2 ICP-MS to measure single nanoparticles and established the particle size distribution of silver nanoparticles in the meat. This shows you the sorts of challenges we're going to see increasingly.

LCGC: Are there standardized and approved methods to measure migration of contaminants from food contact materials into food?

Gilbert: There are something like 90 published standards from CEN, the body that's responsible for publishing European standards. Most standards use GC and LC. One or two standards use GC-MS, but these standards don't use cutting-edge technology because of the length of time it takes to validate methods and to ultimately adopt them as standards.

LCGC: Are there international guidelines for analytical quality control of the methods of analysis used in food contact materials?

Gilbert: A CEN standard covers validation and interpretation of methods, migration testing and analytical data for materials and articles in contact with food. Food control labs must be accredited and they must demonstrate competence. Where we're missing is these very new and sophisticated technologies like LC Orbitrap, where guidance still needs to be developed.

LCGC: Where do you see regulations heading in the area of contaminants from food contact materials?

Gilbert: I can only speak from an EU perspective, but the original plan was always that plastics would be regulated first. Then regulators would move to coatings, printing inks, paper and board and gradually work through different materials.

There are some other non-regulatory bodies, like the Council of Europe that have progressed with paper and board and printing inks, and there have been ad hoc regulations on active and intelligent packaging. We will ultimately see a broader scope of regulation, but it's a very slow process.