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Foreign body complaints in the food and drink industry

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Foreign bodies form the biggest single cause of consumer complaints received by many food and drink manufacturers, retailers and enforcement authorities. The accidental inclusion of unwanted items may sometimes occur in even the best-managed processes. Foreign bodies in foods are therefore quite rightly a matter of concern to all food manufacturers and retailers.

Publicity surrounding food issues, such as glass contamination incidents, concerns about *Listeria, Salmonella* and other micro-organisms in a range of foods, and more recently the presence of horsemeat in products labelled as beef have left consumers very aware of the safety and quality of their food. This has been encouraged by increased coverage in the media of consumer rights, and the growth of social media where consumers can publicise their complaints without having to interest the press or television. The development of an increasingly litigious society and no-win no-fee law companies is a further factor. Therefore, any measures that can be taken to lessen the incidence of foreign bodies in foods are important to food manufacturers, retailers and enforcement authorities. Foreign bodies must be accurately and cost-effectively identified in order to respond to consumer complaints to ensure that measures are taken to prevent a recurrence where appropriate and to build a database of complaints to help in the rapid identification of new and emerging trends.

A foreign body may be defined as something that the consumer perceives as being alien to the food[1]. The perception of the consumer is important, since not all foreign bodies are in fact alien to the food, though all have the potential to give rise to a consumer complaint. Hence, foreign bodies can range from items that are demonstrably alien to the food, such as pieces of glass, metal or plastic; through items that are related to the food, such as fragments of bone in meat products; to part of the food itself, such as lumps of starch in a sauce. The potential range of possible foreign bodies is therefore virtually limitless.

Methods used in foreign body identification

Methods used in the identification of foreign bodies are taken from a wide variety of disciplines ranging from metallurgy to biology and forensic science. Knowledge of, or access to information about a wide range of different materials is required in foreign body identification. Edwards[2] gives a general introduction to foreign body identification, whilst a detailed review of analytical methods for a wide range of foreign body types is given by Edwards[3].

Extraneous Vegetable Material

Extraneous vegetable matter (EVM) such as fragments of leaf or stalk are frequently found to be the cause of complaints in vegetables such as peas or beans or fruit such as raisins or sultanas. Woody material from the centre of carrot or parsnip roots or from cabbage stems can result from root crops overwintering or from the use of older cabbages. Examination of the structure under a light microscope, coupled with staining reactions to show the distribution of components such as cellulose, lignin or starch and comparison with published drawings or authentic material, will often lead to a positive identification. Fragments of true wood from broken boxes or pallets may often be identified by their softwood structure and sometimes the presence of paint. Fragments of hardwood are frequently found to be pieces of tree branch or twig, probably inadvertently harvested from the hedgerow at the edge of a field.

Insects and other invertebrates

Most food companies dealing in a broad range of food products, but particularly those involved with fresh produce, regard complaints about insects as one of the most important foreign body problems. One of the main reasons for this is the difficulty of detecting and removing insects on a production line, particularly in fresh produce.

Whether the insect is a crop or storage pest specifically associated with the product, or simply an incidental contaminant, its accurate identification is crucial to the correct identification of the source of the problem. This work is generally carried out under the light stereomicroscope, with reference to published keys and descriptions and, where possible, authentic reference samples. Field pests and storage pests are generally well studied and documented, and so their habits and requirements are well known, as are suitable control measures.

Other invertebrates, particularly spiders, slugs and snails are also occasionally harvested accidentally with field crops, and may therefore be reported as foreign bodies. Small marine animals are sometimes accidentally caught with seafood, particularly bottom-feeders such as prawns.

Vertebrate animals as foreign bodies

Small animals, or parts of animals, are relatively rare as foreign bodies, but have great potential for bad publicity. Small rodents such as field

mice or voles, or occasionally lizards, frogs or toads, will occasionally get accidentally harvested with field crops. Rodent infestations in food storage or production areas may also result in contamination, although in this case the contamination is most likely to be with droppings from the animals, where hairs from the animals can help in positive identification. However, small animals, particularly rodents, are also sometimes the subject of deliberate contamination, either in the supply chain or by the consumer, because of their potential for bad publicity for the food company concerned. It is therefore particularly important in these cases to gather all possible information about the circumstances of the find and to examine the animal remains in detail for evidence as to how and when it died and whether or not it is likely to have been processed with the product. As with invertebrates, identification is generally a matter of physical examination with reference to published keys and other information.

DNA analysis

Where only parts of an animal are involved, identification may be more difficult, and here the use of DNA analysis and comparison of results with published sequences is a method with great potential. If DNA can be extracted from the sample, a vast and growing amount of data is now available which may allow the animal or plant to be identified at least to a group level if not to species. Where human samples such as hair are to be traced to a particular individual, a specific problem is obtaining suitable reference samples from all of the likely sources. Samples also vary in the ease with which DNA can be extracted from them. A further difficulty is the potential for cross-contamination with DNA from the food in which the foreign body was found, or from those who may have handled the sample after discovery.

Hairs and fibres

Hairs and fibres may originate from a range of sources. Animal hairs, including human, are recognised by the presence of scales on the outer surface, and the different patterns of scales, together with other features such as the structure of the central medulla, may be used to identify the species of origin. The presence of human hair may be an indicator of poor hygiene practices on a food production line, but may equally well originate from accidental contamination by the consumer. The presence of rodent hair may be an indicator of rodent infestation at some point in the food chain. Woollen fibres may have originated from clothing. Vegetable fibres may originate from sacking or twine, or possibly from compost used in growing crops. These are usually identified by their structure under the light might microscope. Artificial fibres can be recognised by their microscopic structure when viewed in cross-polarised light, and can be identified in the same way as plastics using FT-IR spectroscopy.

Plastic materials

With increasing use of plastics in everyday applications and the difficulty of detecting them on-line, many food companies regard plastics as one of the most important causes of foreign body complaints. Sources include food packaging materials, plastic sacking or twine used in packing the raw materials, and parts of piping or machinery can sometimes find their way into products as a result of breakages. However, fragments of consumer equipment are also common sources, with pieces of kitchen equipment such as food mixers being especially common. Complainants often mistake clear

colourless plastic fragments for glass, and in some cases, these result from the substitution of plastics such as Perspex for glass, for safety reasons. Of the various methods for identifying individual polymers, the best is FT-IR spectroscopy, and with Attenuated Total Reflectance (ATR) sampling, the method is completely non-destructive, allowing further investigation of the foreign body being examined.

Metals

Despite the widespread use of magnets and metal detectors on food production lines, a wide range of metal fragments are still reported from food products, although they are often very small. Energy-dispersive X-ray microanalysis is a quick and non-destructive method which can be used for analysis of all metals, usually carried out in a scanning electron microscope. The type of metal involved is usually an important indication of the source of the problem. Pieces of wire are particularly difficult to detect on-line and pieces of broken sieve, fragments of electrical wire from repairs, either in the factory or the consumer's home may be found. Pieces of metal from the manufacture of can ends are a particular problem because the ends are stamped out of a flat sheet of metal, leaving behind a relatively fragile fretwork of waste metal, and a key feature in their identification is often the type and distribution of lacquer on the surface(s). Pieces of aluminium from baking trays, scraped from the surface by mechanical contact, are sometimes found. Similarly, fragments of stainless steel from food machinery are sometimes reported, and the precise composition of these steels can be helpful in identifying the source of the problem.

A source of metal fragments which is related strongly to either hard foods such as biscuits or crusty bread, or to sticky foods such as toffee, is dental fillings. Metal dental posts, used to secure large fillings or crowns, are also found, with or without the relevant filling or crown. Other dental samples, such as tooth fragments, or temporary crowns made of polycarbonate or polymethylmethacrylate, also occur.

Glass

Fragments of glass reported from food products are amongst the most important of foreign bodies, because of the emotive impact on the finder, the reputation of glass fragments for causing injury and hence the potential for bad publicity. However, most glass fragments reported as foreign bodies result from accidental contamination in the consumer's home rather than from raw materials or the factory production line. Food companies will generally have 'no glass' policies to keep all sources of glass well away from production lines, whereas once the food product reaches the consumer's kitchen or dining table, not only is there glassware in the vicinity, but glassware is being used in direct contact with food. It is therefore not surprising that most glass contamination originates from the consumer's own home.

Domestic glassware

Ordinary domestic glassware such as drinking glasses or sweet dishes may occasionally be broken in use. Glass fragments reported from products heated by the consumer in an oven or microwave often include a high proportion of 'heat resistant' glass from the rims of domestic items such as bowls and casseroles. The rims of casseroles often have a characteristic chunky profile, and frequently carry burnt-on food from previous use and scratch marks as a result of contact with the lid of the casserole. Slivers broken from the rims of bowls are also common.

Finally, the identification can be confirmed by X-ray microanalysis, which will show the characteristic elemental composition of a heat-resistant glass.

Objects frequently mistaken for glass

Examples of salt and also sugar crystals, often added by the consumer themselves, being mistaken for glass are surprisingly common. Another material often mistaken for glass is Struvite or Magnesium Ammonium Phosphate, a clear, colourless crystalline material occasionally found in canned fish products such as salmon, tuna or crab, which is formed during the canning process. Other objects frequently mistaken for glass include glass-like minerals such as quartz and other silicates, and clear colourless plastics such as Perspex, polycarbonate or polystyrene.

Other foreign bodies

The possible range of foreign bodies is almost limitless, and only a small range can be considered here. Stones, sand and soil may be incorporated when soil-based crops are harvested, as well as other debris in the soil. Many parts of food processing machinery and packaging have the potential to become foreign bodies, as do a wide range of ordinary household objects. Medical tablets and capsules are occasionally reported, but these usually result from accidental contamination by the complainant themselves. A range of chemical methods can be used to identify the active ingredient(s) in such cases, but if the item is complete, a computer database of tablets and capsules is an invaluable aid to rapid and accurate identification.

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Biography

Mike Edwards trained as a plant pathologist and has headed the Microscopy Section at Campden BRI since 1987. The prime responsibility of the Microscopy Team at Campden BRI is the identification of foreign bodies that have been reported in food products. This work uses a wide range of microscope techniques, including light and scanning electron microscopy, X-ray microanalysis and FT-IR microscopy. Research and development work is also carried out on food structure and texture, product development support, troubleshooting food packaging issues of all kinds, and investigations of micro-organisms on food and machinery surfaces. Mike has also worked on surveys of tin in canned food products and on lead and cadmium in food. Prior to joining Campden BRI, Mike carried out microscopy research in plant pathology and plant physiology at the University of Aberdeen.