Disease-detecting lab in the palm of your hand

July 1 2008

Detecting food-borne diseases such as campylobacter and salmonella long before they enter the food chain would help ensure that the dinner on your table is safe to eat.

There is no quick and simple way to detect infectious bacteria on farms, or even in food processing and distribution plants. Samples have to be sent to labs for testing, a process that can take hours or days.

But what if tests for campylobacter and salmonella could be run on the spot in as little as half an hour? The result, say European researchers, would undoubtedly be a dramatic improvement in food safety.

Campylobacter and salmonella are particularly nasty bacteria that are responsible for most cases of food poisoning around the world.

The idea of a lab-on-a-chip, a device small enough for someone to carry around but able to perform many of the tests normally carried out in a full-sized laboratory, has been around ever since microelectromechanical systems (mems) technology made it possible to put sensors, fluid channels and optical components into a small space.

However, the costs of producing such a system and the failure of many developers to incorporate a means of preparing samples on the spot has meant that few have gone into commercial use.

From testing food to detecting disease

A team of European researchers has addressed those problems, creating one of only two prototype systems in the world that prepare samples and perform DNA tests on bacteria in a portable, easy-to-use and cost-effective chip.

Their work, carried out in the EU-funded OptoLabCard project, will lead to the development of portable devices that can detect bacteria in the food chain and diseases as diverse as cancer, hepatitis, AIDS and flu in humans. Their work could also be used to develop portable devices that can identify pathogens and pollution in water supplies.

“The uses for these devices are almost endless… and the market is huge,” explains Jesús M Ruano-López, coordinator of the OptoLabCard project at Ikerlan-IK4 in Spain.

What sets the OptoLabCard prototype apart from previous devices is the material used to manufacture the components of the chip, and the way in which samples are prepared prior to testing.

Using a single material for most components – a negative thick photoresist – makes the chips simpler and cheaper to produce.

The chip itself is disposable, while a reader or base unit contains all the electronics and optics. Meanwhile, incorporating sample preparation into the chip means that users can effectively replicate laboratory processes out in the field.

“Sample preparation is perhaps the most crucial part but it was abandoned by earlier developers,” Ruano-López notes. “After all, in order to detect the presence of bacteria it is essential to have a reliable sample.”

Rubbing a swab across a chicken carcass, for example, might produce a sample containing as few as ten bacteria, an amount that could go undetected once transferred into the device.

That inability to provide a representative sample could lead to the bird or the entire batch to be deemed clean, when in reality the meat may be covered with dangerous pathogens.

To get around the problem and to improve detection accuracy, the team incorporated a method of concentrating the sample before testing. They used magnetophoresis and the polymerase chain reaction (PCR) technique. PCR is a well-established method of replicating DNA to create higher concentrations.

“By using PCR for sample preparation we can create more concentrated bacteria samples, and because it works with DNA it means that the same device can be used to detect many different types of bacteria and diseases,” Ruano-López says.

So far the device has been used experimentally to detect salmonella in faecal samples taken from hospitals, and will soon be used in Denmark to test for campylobacter on chicken farms.

Cutting the cost of gastrointestinal infections

Testing for campylobacter is a particularly practical use for this technology because of the bacteria’s high prevalence in poultry, explains Dang Duong Bang, a senior researcher at the Danish Institute for Food and Veterinary Research, which will conduct the trial.

“If the device works as promised and leads to commercial products it will offer major benefits for farmers, processors and especially consumers,” he says.

Doung Bang points to studies that suggest the cost of treating gastrointestinal infections caused by campylobacter amount to the equivalent of €600 million in the USA and about €200 million in Britain alone each year.

Faster and more effective testing would undoubtedly reduce the number of infected animals reaching the market.

Ruano-López says a product based on the OptoLabCard prototype could be ready for use commercially within three years, but the project team are not stopping the development of the device.

Toward a lab-on-a-patch

A spin-off company, called microLIQUID has been set up to commercialise components built with SU-8, while several of the project partners have recently launched a new project, called LabOnFoil, in which they will seek to create sample processing and detection chips on foils instead of traditional silicon wafers.

This work would not only bring down the cost per test by a factor of ten, to between 50 cents and €1.50, but it could lead to skin patches able to detect and monitor disease, contamination and drug abuse, says Ruano-López. The patches would be able to be read by a smart card.

Such developments would certainly turn tiny, portable laboratories into a ubiquitous technology, able to detect disease and ensure the safety of food anywhere at any time.

OptoLabCard received funding from the EU's Sixth Framework Programme for research, while LabOnFoil is being funded by the Seventh Framework Programme.

Source: ICT Results