ANALYTICAL TESTING

Sorting the Bad Eggs From the Good

The EU egg scandal caught the headlines this summer. The economically motivated adulteration of food has been estimated to cost the food industry up to $40 billion per year. This burden is borne by industry, regulators and ultimately consumers.

by Maartje Geraedts

A snowballing scandal over an insecticide in eggs has revived discussions around food safety. The total damage of the fiprinol scare to the Dutch food industry alone will run into the tens of millions of euros. The continuous challenge is to develop better and quicker methods to detect biological and/or chemical contaminants in food products.

At the time of writing, the 2017 fipronil egg scandal had affected 17 nations worldwide, according to EU officials. This includes 15 European Union Member States, plus China and Switzerland. EU trade and agriculture spokesman Daniel Rosario said that farms have also been blocked in France and Germany. Checks are being conducted on chickens bred for meat over concerns that they, too, may have been treated with fipronil. The impact of releasing an unsafe product to the market can be devastating. "Every year several products have to be removed from stores, due to the presence of undesired or even toxic components in the food products," says Heidi Ottevaere, Professor at the Vrije Universiteit Brussel and Brussels Photonics Team (B-PHOT).

A Testing Success Story

Fipronil is a compound that is actually included in the standard European monitoring programs. This was the reason why they discovered that there was a problem with this compound. In this case, things worked out quite well in terms of food safety testing, as the issue was discovered and most commercial companies have increased their frequency of fipronil testing. Heather Hancock, Chairman of the UK Food Standards Agency (FSA) says: "I'm confident that acting quickly is the right thing to do. The number of eggs involved is small in proportion to the number of eggs we eat and it is very unlikely that there is a risk to public health. Based on the available evidence, there is no need for people to change the way they consume or cook eggs. However, fipronil is not legally allowed for use near food producing animals and it shouldn't be there." The National Institute for Public Health and the Environment (RIVM) argues that the health risks are very low, particularly for eggs that have been processed into finished products "Foods in which eggs are processed that are infected with fipronil are safe to eat. If the substance is in it, the concentrations are so low that they do not pose a health hazard," says Marian Geluk, director of the Federation of Dutch Foodstuffs Industry (FNLI), based on industry research.

The Cost of Fraud

The economically motivated adulteration of food, or food fraud, has been estimated to cost the food industry up to $40 billion per year. This cost is borne by industry, regulators and ultimately by consumers. Thus detection of fraud is critical to ensuring the safety and quality of food products. The cost of a recall may be large, but the value of protecting a global brand name is priceless.

Obtaining an independent verification of product safety and stability is an essential part of a quality assurance process, required by many major retailers to ensure the safety of the products they sell. "Food safety testing is based on scientific knowledge of the critical points during the food production process," says Ottevaere. Routine food safety testing is carried out

Table 1: Food Protection Risk: Examples, Cause and Effects

Risk Type	Example	Cause and Motivation	Effect	Public Health Risk Type	Secondary Effect
Food Quality	Accidental bruising of fruit	Mishandling	Unsalable product or possible additional contamination	None, or possible food safety	Reduced product/brand equity or food safety incident
Food Fraud	Intentional adulteration of milk with melamine	Increased profit margins	Toxic poisonings	Food safety	Public fear and possible lower prices industry-wide
Food Safety	Unintentional contamination of raw vegetables with *E. coli*	Limited field protection and control during harvesting and processing	Illness and/or death	Food safety	Damaged industry, recall expense, and public fear
Food Defense	Intentional contamination of ground beef with nicotine	Revenge against the store/manager through injury to consumers	Non-lethal poisonings	Food defense	Adulterated product, damaged industry, recall expense, public fear

Source: J. Spink and D.C. Moyer, "Defining the Public Health Threat of Food Fraud," Journal of Food Science, 2011.

according to the legislative requirements, in order to detect biological and chemical contaminants that can occur during the food production process.

Using the same approach in food defense could be problematic, where the motivation for an attack can be political, criminal or economic and the agents used may be novel to the food chain in question. "It is important that we develop new methods or optimize currently existing methods to monitor product safety," says Ottevaere. "The most important is that the methods are non-destructive and fast, meaning that we can do more and more in-process testing, without having to destroy the tested products."

Food Safety Tests

The food safety testing market is projected to exceed $15 billion by 2019, with North America dominating. New rules under the Food Safety Modernization Act (FSMA) have increased the requirements to ensure that the products placed in the US food supply are safe, have been tested and that the testing has been verified and recorded. Analytical testing of food products can be done to detect or confirm microbial contamination, chemical contamination, allergens and food authenticity. "Currently there are many different types of tests for food safety," says Ottevaere. "There are chemical methods, microbiological analysis, electrical methods and we are investigating optical methods." The type of test that is used depends on the food that has to be tested.

She explains: "Not every method can be used as a standard for all food products. For example, with the optical method, we look at the interaction of light with the product. The chemical structure of food determines how the interaction occurs and this is of course not the same for every product." However, the question remains of how reliable the current test to detect food fraud is. "A lot of good healthy food is currently still being destroyed, costing the industry a lot of money," notes Ottevaere. That is exactly the reason why the optical screening methods we use prevent unnecessary food waste. In addition, there are many products that are very susceptible to food fraud."

Fraud With Olive Oil

Of all the instances of food fraud, olive oil leads the way, followed by milk, honey, saffron, and orange juice. Experts say that as much as 70 percent of the oil sold in America is adulterated or of a lower grade. This big fraud is leading consumers to believe it is all fake. "Most olive oil fraud involves the 'fake' oil being diluted with poor quality oils like palm, soybean or sunflower oil," says Ottevaere. Some even say that bottles sold in the supermarkets did not contain any olive oil at all and were instead full of artificial colorings and flavorings.

"In the past, there were a lot of tests to detect fraud with olive oil," says Ottevaere. The best way to test olive oil for both purity and quality is to use both sensory and chemical tests that are endorsed by the International Olive Council. The results of these two sets of tests determine the grade into which it is classified, with "extra-virgin" at the top of the list. However, nowadays, high-quality olive oil is diluted with low-quality olive oil or extra-virgin olive oil is made of very low quality, by typically incorporating older - and often rancid - stocks of oil left over from bumper crops

› Timeline of Europe's Fipronil Egg Scandal

November 2016: The Dutch food safety agency receives a tip-off about fipronil. It investigates and finds no danger to public health, and later clarifies that the case did not involve eggs. It did not notify other countries.
January 2017: Belgian company Poultry Vision begins using a detergent to kill chicken mites that contains fipronil.
May 15: A Belgian poultry farm performs a fipronil test.
June 2: Belgian food safety authority AFSCA receives a warning from a farm about fipronil levels.
June 3: AFSCA sends inspectors to the farm, interviews the owner and takes samples.
June 14: After studying the samples, the agency finds "light contamination" of eggs, with leads about the source of the contamination pointing to the Netherlands.
June 15: AFSCA sends all its information and data to Dutch authorities.
June 19: AFSCA asks the Dutch for an update about the Dutch company involved. It receives no response.
June 26: AFSCA reminds the Dutch of its query.
June 28: Dutch authorities inform Belgium of checks they are carrying out, but still do not release the requested information. AFSCA "formally demands" information concerning Belgian farms treated by a Dutch fipronil-selling business.
July 13: Dutch authorities let Belgium know that they have opened a criminal investigation into businesses under their jurisdiction. This blocks Dutch food safety agency NVWA from handing over desired information, barring a European search warrant.
July 6: Due to a lack of response, Belgium formally requests the information through the EU's Administrative Assistance and Cooperation system against food fraud.
July 20: Belgian authorities raid a suspect business and seize thousands of documents. Through these documents, they discover the list of affected Belgian businesses they were looking for. Authorities also discover for the first time that the fipronil product (Dega 16) may have been used in countries other than Belgium and the Netherlands. Belgium alerts the EU.
July 24: Belgian health and agriculture ministers are informed about the contamination for the first time. A Belgian poultry farm performs a fipronil test.
August 7: The European Commission announces that the contaminated eggs may have been sold in seven countries.
August 8: AFSCA admits test results that show the eggs contain a level of fipronil that poses a risk to human health.
August 10: Dutch police arrest two directors of Dutch company ChickFriend who were suspected of playing a significant role in the scandal.
August 11: The Commission announces that contaminated eggs could be in as many as 17 countries.▼

from previous seasons.

"This mixture of different olive oils is a lot more difficult to detect," explains Ottevaere. "We have developed an optical testing method that allows us to determine the differences between the types of olive oil. We determined the optical spectrum of the different olive oils after 'white light' was absorbed, and looked at the differences between the oils. This allowed us to distinguish between the high-quality and low-quality olive oils." "Another issue with testing olive oils is that most of these oils contain particles. "When we use light to detect differences, these particles scatter the light in all directions and has an influence on the spectrum," she explains.

Currently, olive oils are filtered before they are tested for contents. "Testing for fraudulent foods should not involve preprocessing of the products, as it increases the complexity of testing and you may also remove the fraudulent compounds," adds Ottevaere.

Herbal Supplements Fraud

Another up and coming area for fraud is herbal supplements. Just recently, the Dutch Doping Authority issued a warning for all athletes to be aware of sports supplements. They examined 66 supplements that focus on hormone regulation, muscle strength, weight loss, fat burning or getting more energy. In more than one third (38 percent) of these supplements, doping substances were found, while not mentioned on the label.

"The problems are widespread and the quality control of many companies, whether through ignorance, incompetence or dishonesty, is unacceptable," says David Schardt, a senior nutritionist at the consumer lobby group, the Center for Science in the Public Interest.

The FDA requires that companies test the products they sell to make sure that they are safe. However, this system operates on the honor system, as they can be sold and marketed with little regulatory oversight, and the supplements are only pulled from the shelves following complaints of serious injury.

DNA barcoding, developed about a decade ago, allowed for the identification of substances in the supplements, but it does not allow tests for potency. And because the technology relies on the detection of DNA, it may not be able to identify concentrated chemical extracts that do not contain genetic material or products in which the material has been destroyed by heat and processing to expose the DNA.

The Future for Testing

Increased health and safety risks posed by chemical, microbiological and chemical contaminants have increasingly made analytical testing methods a centerpiece of food safety programs. "When developing new measuring methods to detect food fraud, it is important to look at several products that you know are definitely clean, and then compare these to products that you know are contaminated," says Ottevaere. "If you then see differences, the new method can be used to detect toxic compounds, for example." Using multivariate data analysis, the smallest differences between products can be found. "This will become increasingly necessary to be able to detect fraud," she notes. "People that commit food fraud are aware that there are detection methods available and always looking for new ways to commit fraud that is not or hardly detectable."

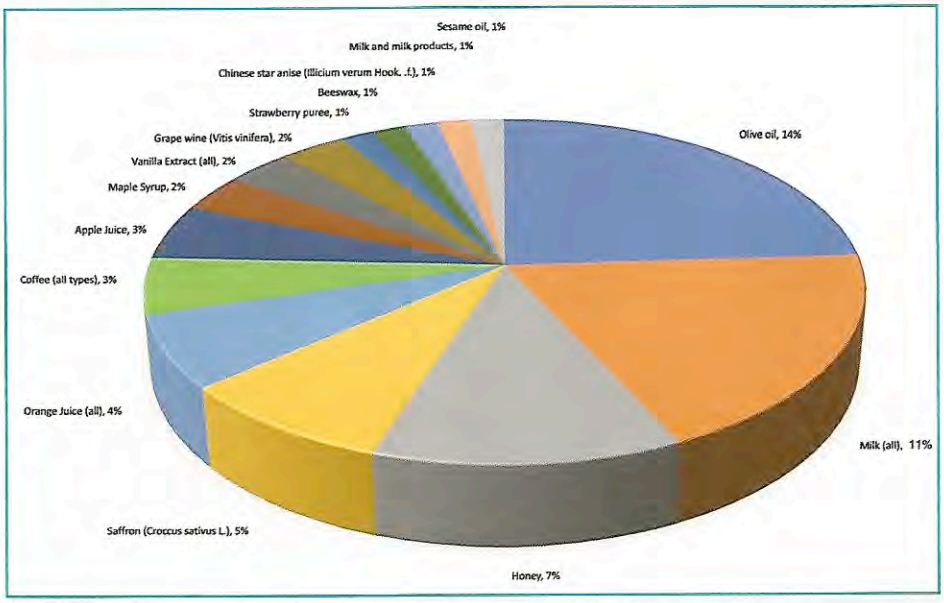
There has also been an explosion of demand in the market for rapid technologies to detect the presence of food contaminants, as they are more efficient and cost effective when compared to traditional manual, time-consuming methods. "The most optimal combination of tests would be that they are non-destructive - meaning that the tested product remains intact and can still be sold cheap, is easy to use and monitored online," Ottevaere explains.

"However, there is still a lot of work to be done," she stresses. "Key is to detect the possible fraud as soon as possible. More multi-disciplinary research is necessary to develop new tests." This could lead to increased consumer protection, while simultaneously reducing the economic burden of testing and product recalls for the industry.

Analytical testing of food products is poised for great growth due to the sheer number of commodities and their complexity. The food industry is seeking rapid testing methods that are cost-effective and highly accurate. Using new and advanced techniques that are highly automated is the only manageable path forward.▼

Table 2: The Differences Between Food Safety and Food Defense

Field	Food Safety	Food Defense
Protection Principle	To ensure food is safe to eat, free from naturally occurring infectious/ toxic contaminants.	To prevent/mitigate the effects of a deliberate attack on the food chain.
Contaminants	A limited number of known pathogens and contaminants, that can cause foodborne illness.	Very wide range of possible contaminants, depending on resources and knowledge of perpetrator.
Cause and Motivations	Naturally or accidentally occurring in the food chain.	Random act, underlying financial. Behavioral or ideological motivation.
Prevention (Legislation)	EU and international legislation: based on hazard assessment/risk analysis principles for each food chain.	No EU or international legislation, only guidelines.



› *The fifteen most problematic ingredients for EMA. Source: US Pharmacopeia*