

Mass Spectrometry

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The Melamine Scare and Its Impact on the Global Food Supply Chain

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Recent news reports about melamine-tainted infant formula in Asian countries have sparked new concerns about the safety of the global food supply chain. Reminiscent of a similar scare in March 2007 involving pet food in the United States, government regulatory agencies around the world are developing scientific methods to detect melamine and its metabolites in quality-control checks to ensure the safety of the food supply for both humans and animals.

News coverage about the presence of melamine in infant formula, cookies and candy has once again raised public concern about the chemical in the food supply chain for both animals and humans^{1,2,3}. The presence of the chemical in infant formula and dairy products has now been linked to kidney problems in thousands of Chinese children. Melamine — an industrial-grade chemical commonly used in the manufacturing of plastics, flame retardants and other products — has a high nitrogen content that makes it possible for unscrupulous food manufacturers to boost the protein content of food products, which can deceive certain quality-control checks that are standard in the food industry.

Melamine's physical properties — a small molecular structure, plus its typical form as a white powder — make it very difficult to detect in a physical or visual examination of a food product, particularly in milk and milk products. The chemical's high nitrogen content can make watered-down milk laced with melamine appear to be protein-rich in quality-control tests because protein is also high in nitrogen. Current allegations that food manufacturers have added melamine to make it seem that there is more protein in a product, which is one claim monitored in food quality-control tests. The global implications of this discovery are still unknown, as both the United States and European countries import food and ingredients from all over the world including Asia Pacific.

Previous Concerns about Melamine

This latest outbreak of melamine-contaminated food comes just over one year after the announced presence of melamine and cyanuric acid in pet food^{4,5,6}. During this earlier occurrence, the presence of melamine in pet food went unnoticed initially because routine safety checks do not test specifically for melamine or its metabolites. In 2007, an unusual number of deaths in otherwise healthy pets sparked an investigation into the pet food industry, where melamine was found to be present in the food supply. The discovery of contaminated vegetable proteins imported into the United States from China caused a nationwide pet food recall that began March 15 2007. Additionally, a portion of the tainted pet food was used to produce farm animal feed and fish feed. The FDA and the U.S. Department of Agriculture discovered that some animals that ate the tainted feed were processed into human food^{7,8}.

News coverage about the presence of melamine in pet food, animal feed, wheat gluten and other protein-based food commodities raised public concern about the chemical in the food supply chain for both animals and humans. Although all western countries conduct safety checks for contaminants and the quality of the products, melamine was not picked up in initial routine safety tests because the regulatory agencies did not look for it until the pet food scare. At the time, melamine was a new contaminant that was unexpected.

Regulatory Agencies Respond

Melamine is not approved for use in food or animal feed. Recently the U.S. Food and Drug Administration (FDA) announced that eating a very tiny amount of melamine — 2.5 parts per million — would not raise health concerns, even if a person ate food that was tainted with the chemical daily. Officials also said that infant formula sold to U.S. consumers must be completely free of melamine⁹. "If products are adulterated because they contain melamine, (authorities) will take appropriate actions to prevent the products from entering commerce," the FDA said in a statement. The agency said the 2.5 parts-per-million standard was intended to address situations where the chemical accidentally comes into contact with food, such as where it is used for industrial purposes in a factory that makes food products.

In Europe, the European Commission Joint Research Centre's Institute for Reference Materials and Measurements is gathering information and reviewing methods to detect melamine in food and feed products to address concerns about possible melamine contamination in products on the European market¹⁰. Although the EU does not import milk or other dairy produce from China, processed foods such as biscuits and chocolates can contain imported milk powder. The European Commission recently decided that all products originating from China and containing more than 15% of milk as an ingredient must now be checked for the presence of melamine. In order to protect the European citizen, products containing more than 2.5 mg/kg of melamine are to be immediately destroyed.

The United Kingdom's Food Standards Agency is an independent government department that was set up by an act of the British Parliament in 2000 to protect the public's health and consumer interests in relation to food. The agency reports that local authorities at seaports and airports carry out regular checks on imported food to ensure that it meets strict EU food safety requirements. The Food Standards Agency works with port health authorities and local authorities to ensure EU controls are strictly enforced. According to the agency, there has been a longstanding ban on the import of milk and other products of animal origin from China as controls on the food industry in China do not meet the very strict requirements set in the EU.

Detection Techniques for Melamine

Detecting melamine in food requires methods that are sensitive and accurate enough to detect very low levels of contaminants in complex samples typical of most food products. One of the preferred methods for detecting melamine in food products is LC-MS/MS (liquid chromatography coupled with tandem mass spectrometry) analysis.

After melamine was discovered in pet food last year, the FDA developed a method for detecting melamine in catfish¹¹. *Laboratory Information Bulletin No. 4396* states, "Because animals may eat food contaminated with melamine residues, there is a need for analytical methods to determine melamine residues that may be present in animal tissues." To develop this method, the FDA used the Thermo Scientific TSQ Quantum triple quadrupole mass spectrometer (Thermo Fisher Scientific, San Jose, California) coupled with a Thermo Scientific Surveyor LC-MS pump and autosampler. The method showed that the Thermo Scientific instrumentation detected melamine at levels of 10 parts per billion in catfish extract, exceeding the agency's requirements. See Figure 1.

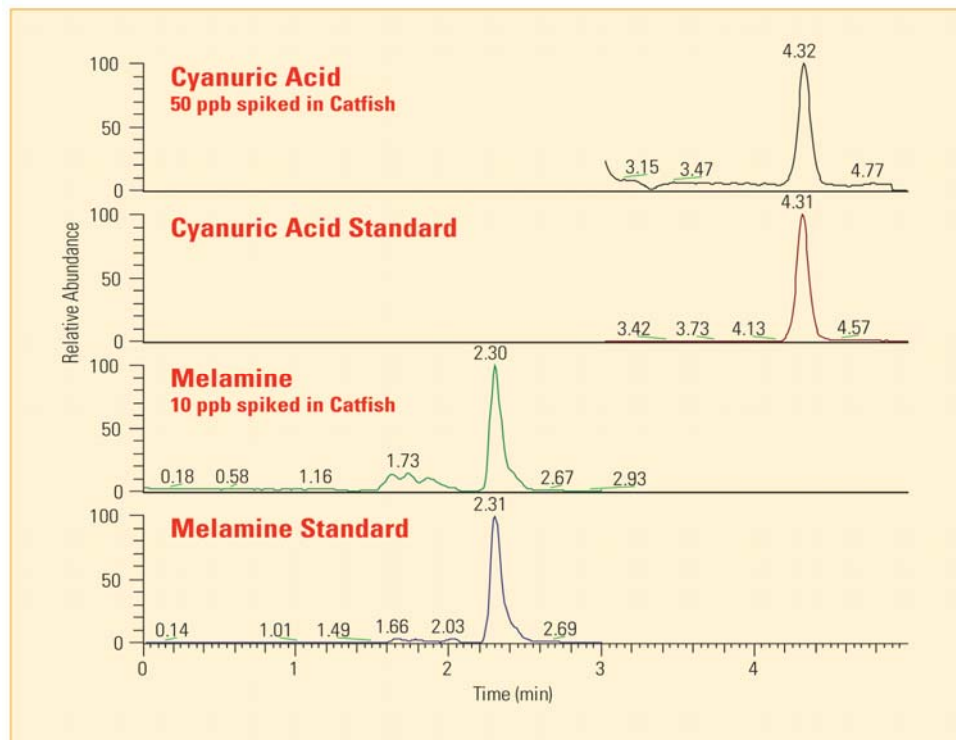


Figure 1. Chromatogram of cyanuric acid and melamine spiked into catfish matrix, at a level of 50 ppb for cyanuric acid and 10 ppb for melamine.

In a separate development, the National Center for Food Safety and Technology (NCFST) needed to quickly learn more about the effects of food processing on the chemical to learn how to accurately detect the presence of melamine in food. The NCFST incorporates the FDA Division of Food Processing Science and Technology and was established in 1988 by the FDA to form a link with industry to share expertise in food technology. The NCFST enables industry representatives to work collaboratively with FDA scientists on food safety and technology research projects.

In July 2007 the NCFST began using the Thermo Scientific TSQ Quantum Ultra triple stage quadrupole system coupled with the Thermo Scientific Accela high-speed chromatography system to develop its LC-MS/MS method to monitor melamine and its hydrolytic products in processed foods¹². The TSQ Quantum triple stage quadrupole system is the only instrument that enables Highly Selective Reaction Monitoring (H-SRM) performance, which facilitates the quick and efficient analysis of complex samples such as animal tissue. The Thermo Scientific LC-MS/MS solution has yielded accuracy and precision values for this method that were well within the guidelines of the FDA for analytical method development and validation.

Conclusion

Currently the LC-MS/MS method developed by the NCFST is being used as a reference by the laboratories under Administration of Quality Supervision, Inspection and Quarantine (AQSIQ) in China to develop a similar LC-MS/MS method using TSQ Quantum systems for the detection of melamine in milk and infant formula. Additionally, many food manufacturers are expanding internal quality-control checks to check for melamine residue in their products, continuing to build on the lessons learned during the pet food recall in 2007.

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