New research reveals food ingredients most prone to fraudulent economically motivated adulteration

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In new research published in the April *Journal of Food Science,* analyses of the first known public database compiling reports on food fraud and economically motivated adulteration in food highlight the most fraud-prone ingredients in the food supply; analytical detection methods; and the type of fraud reported. Based on a review of records from scholarly journals, the top seven adulterated ingredients in the database are olive oil, milk, honey, saffron, orange juice, coffee, and apple juice.

The database was created by the U.S. Pharmacopeial Convention (USP), a nonprofit scientific organization that develops standards to help ensure the identity, quality and purity of food ingredients, dietary supplements and pharmaceuticals. USP's food ingredient standards are published in the Food Chemicals Codex (FCC) compendium. The new database provides baseline information to assist interested parties in assessing the risks of specific products. It includes a total of 1,305 records for food fraud based on a total of 660 scholarly, media and other publicly available reports. Records are divided by scholarly research (1,054 records) and media reports (251 records). Researchers are Drs. Jeffrey C. Moore (lead author) and Markus Lipp of USP, and Dr. John Spink of Michigan State University.

Food fraud was recently defined in a report commissioned by the Department of Homeland Security and funded by the National Center for Food Protection and Defense (University of Minnesota) as a collective term that encompasses the deliberate substitution, addition, tampering or misrepresentation of food, food ingredients or food packaging, or false or misleading statements made about a product for economic gain. A more specific type of fraud, intentional or economically motivated adulteration of food ingredients has been defined by USP's Expert Panel on Food Ingredient Intentional Adulterants as the fraudulent addition of nonauthentic substances or removal or replacement of authentic substances without the purchaser's knowledge for economic gain of the seller.

"This database is a critical step in protecting consumers," said Dr. Spink. "Food fraud and economically motivated adulteration have not received the warranted attention given the potential danger they present. We recently defined these terms [see the Journal of Food Science, November 2011] and now we are defining the scope and scale. As many do not believe a concept or risk exists if it does not appear in a scholarly journal, we believe that publication of this paper in the Journal of Food Science will allow us to advance the science of food fraud prevention."

While traditionally considered primarily an economic issue and less a consumer safety threat, authors of the paper, Development and Application of a Database of Food Ingredient Fraud and Economically Motivated Adulteration from 1980 to 2010, defined empirically that in some ways food fraud may be more risky than traditional threats to the food supply. The adulterants used in these activities often are unconventional and designed to avoid detection through routine analyses. Melamine, for example, was considered neither a potential contaminant nor an adulterant in the food supply before the episodes of adulteration of pet food in 2007 and infant formula and other milk products in 2008 (with tainted products still appearing sporadically today, principally in China). Although, as records from this database indicate, melamine was used as an adulterant to mimic protein as early as 1979; however, this remained virtually unknown until 2007. Hence, testing for melamine was not included in routine quality

assurance or quality control analyses. Additionally, current food protection systems are not designed to look for the nearly infinite number of potential adulterants that may show up in the food supply.

"Food ingredients and additives present a unique risk because they are used in so many food products and often do not have visual or functional properties that enable easy discrimination from other similar ingredients or adulterants throughout the supply chain," the paper states. Glycerin, for example, is a sweet, clear, colorless liquid that is difficult to differentiate by sight or smell from other sweet, clear, colorless liquid syrups-including toxic diethylene glycol, which in the past has been substituted for glycerin with deadly consequences. Diethylene glycol has been fraudulently added to wines, and also used as an adulterant of glycerin used in pharmaceuticals.

In addition to identifying specific food ingredients and food categories vulnerable to adulteration, the researchers also analyzed the types of analytical detection methods used to discover the fraud, as well as the type of fraud using three categories: replacement, addition or removal. The authors found 95 percent of records involved replacement-an authentic material replaced partially or completely by another, less expensive substitute. An example is the partial substitution of olive oil with hazelnut oil. Other examples include potentially harmful substitution of toxic Japanese star anise for Chinese star anise (a common spice used in foods), and the partial replacement of low-quality spices with lead tetraoxide or lead chromate to imitate the color of higher-quality spices.

Utility of Database

The database provides information that can be useful in evaluating current and emerging risks for food fraud. In addition to providing a baseline understanding of the vulnerability of individual ingredients, the database offers information about potential adulterants that could reappear in the supply chain for particular ingredients. For example, records in the database regarding melamine as an adulterant for high-protein-content ingredients date back to 1979. Speaking to that example, the paper notes, "Perhaps if this information had been readily available to risk assessors before the 2007 and 2008 incidents of melamine adulteration and wheat gluten and milk powders, it could have helped risk assessors anticipate these adulteration possibilities." This information also could have stimulated research aimed at developing new methods to measure protein content, which could signal adulteration with melamine and other unexpected constituents-an effort that has only recently gained substantial interest.

Another practical application of the database involves analytical testing strategies to detect food fraud. A commonly used strategy at present is testing for the absence of specific adulterants-an approach that excels at detecting known adulterants at very low levels but has the critical limitation of not necessarily being able to detect unknown adulterants. An alternative strategy is compendial testing (via FCC and other sources) for the identity, authenticity and purity of a food ingredient (i.e., what should be present and in what quantity instead of what should not be present). While this testing may not always be capable of detecting adulterants at trace levels, it is capable of detecting both known and unknown adulterants.

"Well-designed compendial testing approaches can be very powerful tool for guarding against food fraud," said Dr. Moore. "Their potential to detect both unknown and known adulterants is a significant benefit in an environment where no one knows and is worried about what harmful adulterant criminals will use to create the next generation of fake food ingredients."

More information: The USP Food Fraud Database is publicly accessible at www.foodfraud.org

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