

Chemical contaminants in foods—health risks and public perception

November 19 2015, by Christina G. Chase



Important changes are underway in the food industry, as food production becomes an increasingly global process. This transition is creating challenges for food manufacturers, regulators, and consumers as well. Challenges include the interdependence of nations when sourcing and producing foods, supply chain integrity issues, and the wide variety of chemical contaminants that can potentially affect millions of food products. The supply chain has become so complex for certain foods that it is now considered a "supply web." Protecting the public from health

risks posed by chemical contaminants in foods has become a daunting task.

The new globalized [food](#) supply contrasts sharply with the landscape of previous generations, when many foods were grown, manufactured, and distributed within a local area. If a food safety problem occurred, its impact was constrained by geography. Today, when a food safety crisis occurs, its impact can be rapid and widespread, affecting many regions of the world.

Meanwhile, another challenging trend is underway: consumers are seeking more information about the foods they purchase, particularly information about health effects. Despite the regulations that are in place to protect consumers, pervasive fears of chemical contaminants have developed. These worries are often rooted in, or exacerbated by, misinformation from unreliable sources.

Contaminants and Regulations

Regulatory agencies focus their efforts on contaminants with the greatest potential to cause harm. It is not feasible to regulate every substance that may enter the food supply, and therefore some contaminants remain unregulated. Fortunately, available data suggest that many unregulated contaminants have a negligible effect on human health. In these cases, enacting limits would not protect consumers but would create unnecessary regulatory burden, making food more expensive but not safer, said Markus Lipp, PhD, former senior director of food standards at U.S. Pharmacopeia (USP) and currently senior food safety officer, Food and Agriculture Organization (FAO) of the United Nations (UN). Lipp and other experts—toxicologists, food scientists, and regulators—spoke at the "Chemical Contaminants in Foods Workshop—Risk-Based Approaches to Protect Public Health," held at USP headquarters in Rockville, Md., in November 2014.

Nations around the world regulate [food contaminants](#) including pesticides, herbicides, dioxins, PCBs, residual solvents, brominated flame retardants, mycotoxins, veterinary drugs, and heavy metals (i.e., lead, cadmium, mercury, and arsenic). All of these contaminants can pose a threat to human health if consumed in excess, but limits are already in place or are being established for most of them. If the contaminant dose is low enough, there is no risk to the health of consumers from these compounds. The key for [public health](#) is not having a "zero tolerance" for contaminants, but rather keeping intakes of contaminants within safe levels.

Figure 1. Contaminants can enter the food supply at any point from agriculture through packaging.

Source: Claire Kruger, Spherix Consulting

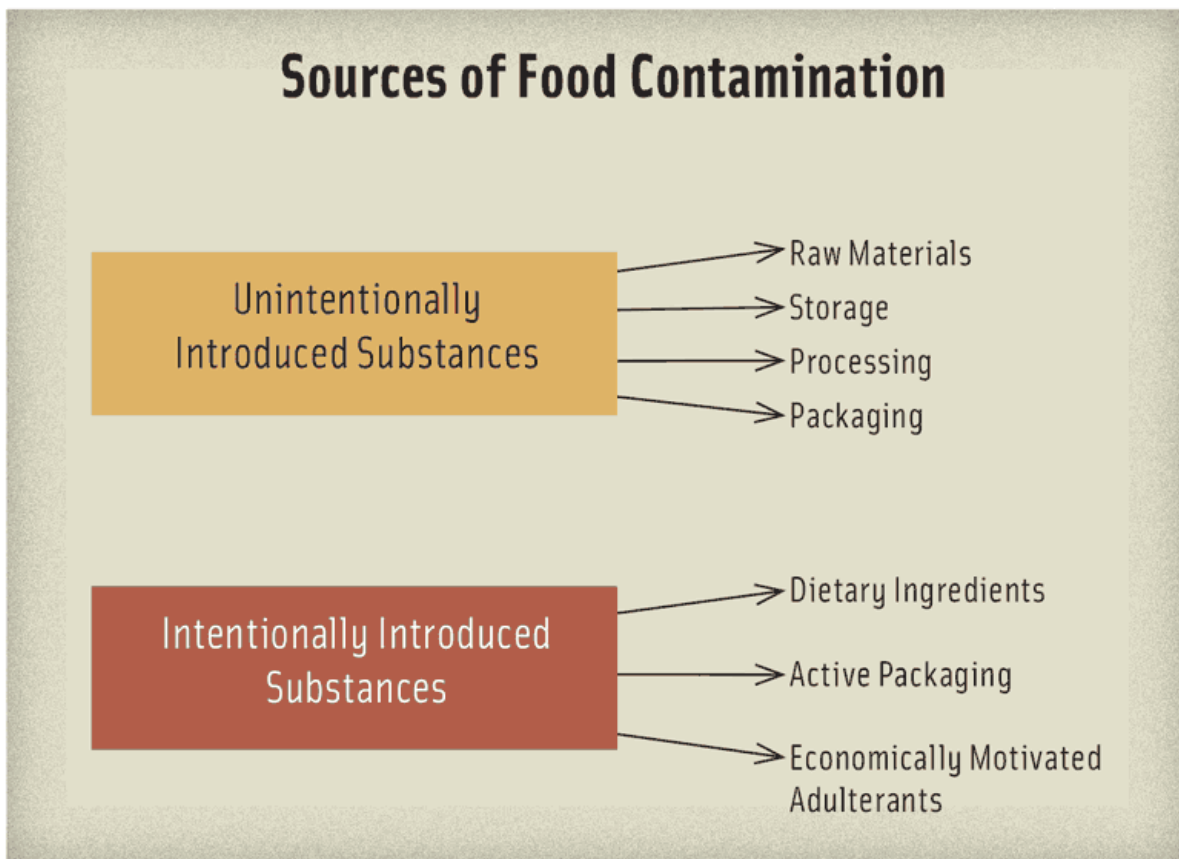


Figure 1. Contaminants can enter the food supply at any point from agriculture through packaging. Credit: Claire Kruger, Spherix Consulting

Contaminants can enter the food supply if they are present in the soil or water. Others are man-made compounds that can enter food at any time during processing, production, packaging, transport, or storage (Figure 1). Most contaminants are unintentional, but some come from intentional illicit activities, noted Claire L. Kruger, PhD, a toxicologist and president of Spherix Consulting, Inc. For example, unscrupulous food producers in China cut costs by adding melamine to diluted milk that was later used in infant formula with disastrous results: some infants fed the formula developed kidney failure and died.

Is Food Safe?

The melamine crisis was a tragic event in which certain specific foods became dangerous. But what about the foods we eat every day—are they safe? "No food is completely safe. Even water can kill you if you drink too much," Kruger explained, adding that everything we eat comes in shades of gray, not black or white, with regard to safety. Foods actually possess degrees of harmfulness because all foods have the potential to cause harm. Potatoes normally contain natural toxins called glycoalkaloids in small amounts that pose no health risk, but during prolonged storage, potatoes can generate higher glycoalkaloid levels that can cause neurologic effects. Another substance, acrylamide, is formed in many foods during baking and frying, and it always has—it is nothing new—but regulators are investigating its health effects (Figure 2).

If all foods have the potential to harm us, can any foods be considered safe? Fortunately, yes, because a food is presumed safe if, under normal circumstances, it won't harm people, Kruger said. When promoting food

safety, we do not eliminate hazards completely (this is why no food is absolutely safe), but we control risk, and this is a critical concept for consumers to understand. Risk is controlled via regulatory limits and standards designed to protect public health. These limits are enforced using robust surveillance mechanisms in many countries throughout the world.

Understanding Risk

Consumers often misunderstand the concept of risk, leading to confusion. Risk is the interaction between two factors: the presence of a hazard in the food, and exposure to it. If a hazard is present, but exposure is low enough, the risk is low. A hazard is a potential harmful effect of a contaminant. Consumers often become alarmed that a hazard is present, not realizing that the likelihood—or extent—of exposure to this hazard (similar to the concept of dose) is extremely important. When educating consumers, this message should be clear: the presence of a hazard does not equate to a meaningful or significant risk. If exposure to this hazard is low enough, the resulting risk can be small, even negligible, with no impact on a person's health.

In 2011, news broke that arsenic had been detected in apple juice, and consumers were alarmed. Many people think of arsenic as a poison, and it certainly can act as a lethal poison. Yet arsenic is also a chemical element that occurs naturally in water and soil and does not harm people if the amount ingested is sufficiently low, said Henry Chin, PhD, Henry Chin and Associates and a member of the USP Food Ingredients Intentional Adulterants Expert Panel. Consumers may assume that arsenic in foods will harm them, but it all depends on the amount of arsenic because "the dose makes the poison." A potentially poisonous substance is only a poison at high enough doses. Consumers want their foods to be completely free of health risks, with zero contaminants, and understandably so. However, a small amount of arsenic will not render a

food unsafe by any stretch of the imagination, said Lipp.

And what does "zero" actually mean? Zero is slightly below the lowest amount that scientists can measure; it's the amount we cannot see or find (and everything below that level). In recent years, laboratory instruments have become extremely precise, detecting miniscule amounts of contaminants that may be meaningless (See sidebar "What Is Zero ... and Where Is It Headed?").

Health risks can be large or small or anywhere in between because they fall along a continuum, but what are these health risks? Put simply, risk of what? Is the hazard an increased likelihood of cancer, or temporary stomach irritation? Do these risks accumulate over time? Some risks do, and safety experts strive to protect people's health over their lifetimes. Clearly, consumers need accurate, practical information about "risk of what?" and "how high is that risk?" Having such information gives consumers a measure of true control as they struggle to choose safe, healthful foods.

Role of the Media

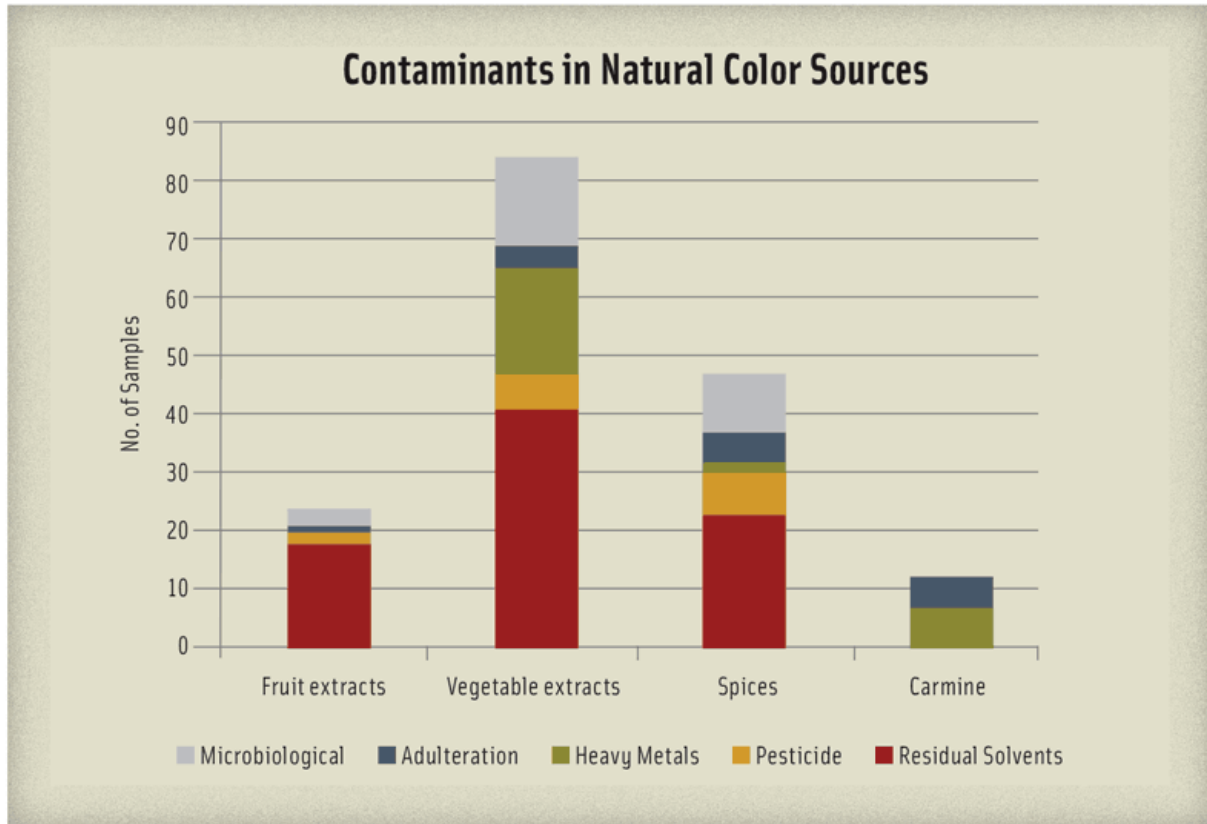


Figure 3. An assessment of 650 samples of natural color sources from around the globe that were imported into the United States found that 1 in 4 or 25% failed QC testing due to a variety of contaminants—microbiological, adulteration, heavy metals, pesticides, and residual solvents. Pesticide levels can become concentrated during the extraction process to levels much higher than are found in the crops. Source: James Simon, Rutgers Univ.

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In countries around the world, consumers are worried, even outraged, about food contaminants. In the European Union, [food safety](#) discussions are "fierce," reported Niels Lucas Luijckx, PhD, food quality and safety consultant, TNO, The Netherlands.

The news media play a very powerful role in risk communication, but this process is fraught with problems. When a new study comes out about foods and health, media outlets rush to publish a story before their competitors do. Usually, news stories describe the study findings in isolation, with little or no context from previous research. What if the new study contradicts previous, rigorous studies performed by independent research groups? Any single study can have flawed methodology leading to biased results. Consumers need to hear the context—the background on a research topic—and they should hear this context simultaneously with the new study's findings. To provide the "big picture," journalists need to include expert commentary whenever news comes out about food contaminants. Yet it takes time to contact the experts and get their comments. Meanwhile, the pace of news reporting has accelerated enormously because of the Internet. News organizations compete for "eyes," and this can certainly inhibit balanced, thorough reporting.

Ironically, even if the media do provide a balanced report, consumers may still misunderstand the relevance of the news to their own lives. They may overreact, eliminating the suspect foods from their diet, even before the verdict is in. Another concern is sensationalism in the news. If scientists report that a food (or a contaminant) is basically safe and there is nothing to worry about, this take-home message may never reach the consumer—it is boring, and won't command the attention garnered by a dramatic headline. Unfortunately, inflammatory headlines about risks in foods, whether truthful or not, can easily shake the public's trust in regulators and food manufacturers. Sometimes this loss of trust is warranted, but sometimes it is not.

Ideally, the public should maintain a healthy degree of skepticism about all news on foods and should hold off on changing their food choices until scientific evidence justifies making such changes (if ever). In reality, the public is bombarded with bits of alarming information, and

each bit is presented out of context. Consumers become suspicious, frustrated, and angry that the advice on "what to eat" keeps changing.

Consumer Beliefs and Behaviors

Frustrated consumers may simply give up on trying to "do the right thing," which is understandable but does not protect their health or give them peace of mind. It's odd that virtually any news about foods and health gets the public's attention, and we don't know why, remarked Jason Huffman, a journalist for Politico Pro. Even more surprising and concerning is the trend of consumers getting most of their "facts" about foods and health from unreliable sources that are not evidence based. The public eagerly takes advice from self-proclaimed "experts" who are not scientists or medical professionals and may have no relevant credentials at all, he added.

Considering these observations, perhaps we should be asking, how do consumers feel, and what are they thinking? Luijckx noted. Consumers feel anxious about choosing food products, he said. To cope with the uncertainty and mixed messages, individual consumers may subconsciously develop "mental models," which are like a set of rules for choosing foods. One consumer might believe that "processed foods" are harmful, concluding that eliminating them will remove all risk. Another person might believe that following a highly restricted diet, such as vegan or gluten-free, will eliminate health risks. On a smaller scale, many consumers put their trust in specific brands or label claims such as "all natural" or "preservative free," which may or may not indicate a healthier food product (Figure 3).

Some mental models are based on legitimate science, but countless others have little or no scientific evidence behind them—they can even be harmful. To complicate matters, sometimes the wrong person latches onto a mental model that would benefit someone else. The gluten-free

diet is prescribed for people with celiac disease, who make up 1% of the population. The other 99% do not need gluten-free foods and will not benefit from them. In fact, by restricting their diets they are limiting variety and potentially taking in fewer nutrients. Unfortunately, many consumers now believe that gluten is harmful and we should all avoid it.

All mental models, whether evidence based or not, have something in common: people who believe in them gain a sense of control, which helps them feel reassured and safe in a world full of contradictions, explained William K. Hallman, PhD, professor and experimental psychologist at Rutgers University. If someone truly believes that eating purple foods, and only purple foods, will protect their health, and they proceed to do so, they will have perceived control.

This concept of perceived control relates to another key theme: "perception is reality." In this common scenario, researchers find that a particular "risk" is tiny and meaningless; it has no relevance to human health. But many consumers have heard about this purported risk and are already anxious. They will disregard any reassurances because they still perceive that a threat exists. Because perception is reality, the "threat" must be addressed (by health officials, food manufacturers, journalists). In fact, the "threat" may even become a high priority for the food industry if certain products are rejected and others are embraced by consumers because of the perceived risk, Luijckx declared.

This phenomenon also illustrates the critical importance of effective risk communication—timely, understandable, accurate messages conveyed by health authorities to the public. Effective communication about risks in foods can keep consumers informed of the real threats while teaching them to spot the false alarms that pose no risk.

Future Directions: Building Trust

Building consumer trust is a challenging process. How can this be accomplished, or more realistically, how can stakeholders take a step in the right direction? First, the food industry needs to be upfront and honest about what it is doing, said Huffman, citing an example when Monsanto failed to put consumers first, and lost their trust. "It's hard to convince people now that biotechnology is a good thing," he added.

Second, health experts should stop assuming they know what consumers want to know. Maybe the public doesn't want the information that the experts keep trying to give them, observed Hallman, and this disconnect creates a barrier to communication and trust. Experts often assume they need to explain the scientific concepts more clearly or make the science more relevant, even exciting. But what if consumers don't want (or need) to understand the science, and instead they really want to know things like:

- Who is behind the development of genetically modified foods?
- Why are they doing this—for profit? For some other reason?
- Can I trust them to create safe foods and protect my family's health?

For the public, it's not about the science, it's about values and control, revealed Hallman. So if stakeholders would ask consumers what they want to know and then give honest, forthright answers, open communication might develop and then slowly lead to trust.

Consumers also want to know why simple, old fashioned foods with limited ingredients are so difficult to find. How can stakeholders turn this situation around and go back to a simpler time when consumers saw their food as safe and wholesome and they had peace of mind about food and their health, asked attendee Joseph Scimeca, PhD, vice president of global regulatory and scientific affairs at Cargill. A related question is, should we continue to chase after individual [chemical contaminants](#), or

would it be more sensible and meaningful to look at a whole food (is this food safe?) or even the whole diet (is this diet reasonably safe overall?), Scimeca inquired.

In Europe, consumers became more confident in the food industry when they visited farms to observe how crops were grown and livestock was handled. Similar descriptive information is available online or in pamphlets from many food manufacturers and government agencies, "but they all have a credibility problem," remarked Lipp. Consumers are often suspicious of industry and government alike, so perhaps there is a role for nonprofit organizations. The credibility of nonprofits, and consumers' trust in them, may be stronger overall; this idea could be assessed in focus groups and surveys.

Effective risk communication strategies are urgently needed, yet funding for this discipline is almost nonexistent, Hallman noted. Meanwhile, consumers routinely turn to self-proclaimed "experts" for guidance about what to eat and what to avoid. These sources are often biased by profit motive—they are selling something—but even if not, they typically provide misinformation because they lack the knowledge, credentials, and judgment needed to provide accurate, useful advice.

How can this pattern be reversed? What can be done to connect consumers with reliable advice and accurate answers to the questions they want answered? No single organization has the reach to accomplish this, so stakeholders need to combine efforts to make headway in this challenging process. The true experts need to become proactive and speak up when they see misleading or biased information in the media. The most valuable research is useless if the take-home message becomes warped or simply lost in transit to consumers, particularly when they routinely turn to unreliable sources instead. When professionals with expertise in science, medicine, nutrition, and health become proactive and find out what the public actually wants to know, perhaps the lines of

communication will open up and a true dialogue might begin. From there, consumers could learn how foods are grown and produced, get their questions answered, and gradually develop trust in the [food supply](#).

Although [health risks](#) from food contaminants will never disappear completely, that is not the goal, and it is also not necessary. The dose makes the poison, and if the dose is kept at a safe level, the risk to human health is negligible, or even nonexistent. The key for public health is not to have a zero tolerance for contaminants, but rather to keep contaminants within tolerable, safe limits. Perhaps the ultimate goal is two-fold: Safe food, and peace of mind from trusting that our food is safe.

What Is Zero ... and Where Is It Headed?

Consumers want zero contaminants in their food, but zero is a moving target because of continuous advances in analytical techniques that are able to detect ever-smaller quantities of particular [contaminants](#) that may be of concern, stated Jonathan DeVries, Medallion Labs/General Mills.

Zero is less than the smallest amount that scientists can measure. That smallest amount keeps dropping as laboratory instruments become increasingly precise. For example, in the 1950s to 1960s, scientists could measure parts per thousand or parts per million. In the 1970s to 1980s, it was parts per million or parts per billion. And in the 1990s and 2000s, it was parts per trillion or parts per quadrillion.

What do these tiny numbers mean? Do they reflect a risk to human health? And how big is that risk? Analytical technology has advanced faster than our ability to interpret the findings.

Furthermore, scientists and consumers view these miniscule numbers differently. For example, 308 ppb equals 0.000000308 g/g. A scientist

sees the number as 0.000000308 but a consumer sees 308 and may be alarmed—this amount looks large. Would consumer anxiety decrease if the value was shown as 0.000000308 g/g versus 308 ppb? Or would 0.000000308 g/g create more confusion for [consumers](#)?

Provided by Institute of Food Technologists

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