Over-regulation of aflatoxin M1 is expensive and harmful in food-insecure countries

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In high-income countries, few people outside of national regulators such as the US FDA and the agrifood value chain have heard of aflatoxin. Aflatoxin B1 is by far the most potent chemical carcinogen to which large numbers of people are exposed. It has the distinction of being the only chemical that is regulated based on human cancer and not rodent data. Discovered in 1962 by British scientists, it was and is a pervasive contaminant of oily crops like corn and peanuts produced in hot, dry summers. It was quickly realized that aflatoxin was having a major effect not just on liver cancer but on child growth (1–3). In 1969, the US FDA issued an action level of 20 ppb in corn based on the analytical methods of the day. Before this, estimated exposure to aflatoxin mainly in the southeastern United States was 100–200 times higher than the current WHO tolerable limit of 1 ng · kg body weight^{-1} · d^{-1} with an associated excess liver cancer rate (4). It turned out that 20 ppb was a sound value from a public health perspective despite the relative lack of data at the time. In bad years such as 2012, aflatoxin contamination in corn resulted in direct losses to farmers and food producers in excess of $1 billion as well as the costs of increased testing and finding alternative sources of corn for mills and food producers (5). Because the US corn crop is so important on a global basis, the cost of grain corn and inverted sugar increased ∼10% worldwide.

Upon ingestion, as part of the detoxification process, humans and mammals produce a metabolite called aflatoxin M1 that was first detected in milk, hence "the milk toxin." This is excreted in the urine and, in lactating animals, milk, including breast milk (1). In rats, aflatoxin M1 is <1/10th as potent a liver carcinogen as aflatoxin B1 (6). Thus began a debate about the human relevance of aflatoxin M1. The US FDA issued a precautionary action level of 0.5 ppb for M1 in milk in 1977 (CFR United States Federal Register 42, 234, 61630: December 6, 1977). This remains the international standard for trade from the Codex Alimentarius. The aflatoxin M1 regulation in the European Union uses 1/10th of that value (or 0.05 ppb). In 2001, the Joint Expert Committee on Food Additives and Contaminants (JECFA) of the FAO and WHO determined that few cancers resulted from aflatoxin M1 exposure and there was no discernible difference in outcome for regulations with a value of 0.05 or 0.5 ppb (7). The cost and difficulty of implementing standards with no value for public health divert resources away from measures that do.

In this issue, Turna et al. (8) have produced an updated analysis of the limited impact of aflatoxin M1 in the occurrence of hepatocellular carcinoma. As with the JECFA, they conclude that on a global basis aflatoxin M1 *may* contribute 0.0001%–0.003% cases of liver cancer worldwide. Why is this important? Between 500 and 750 million people, mainly in Africa but also in parts of Latin America and East Asia, have high dietary exposures to aflatoxin B1. In sub-Saharan Africa, these exposures are at multiples, often orders of magnitude, above tolerable levels (e.g., 1, 2). On the order of 40% of the liver cancer in Africa results from aflatoxin B1 exposure (9). At higher exposures, there is a material effect on child growth. Painful deaths from acute liver toxicosis in children are not uncommon (1, 3, 10). In some regions, exposure to aflatoxin B1 is so high that essentially only during breastfeeding or from milk consumption does a child have a respite from exposure. In Africa, ≤80% of calories are from grains, mainly corn, a crop highly susceptible to aflatoxin and other mycotoxins. Improving dietary diversity—including adding milk to a child's diet—is the only proven but currently unattainable measure to reduce aflatoxin exposure. As elsewhere, in Africa milk can play a critical role in improving child nutrition (10).

Many countries that have difficulty providing sufficient corn relatively free of aflatoxin have regulatory standards, but these are seldom enforced simply because of food insufficiency, thus they are of little practical value (11). Aflatoxin M1 is a common contaminant in milk including breast milk through much of Africa (12).

Turna et al. (8) describe some of the potential harms of over-regulation of aflatoxin M1 milk even as an aspirational goal. In all societies, the affluent are able to purchase better food, possibly including milk with lower M1 concentrations (e.g., 13). A practical example of this reality occurred in Ethiopia in 2015. A survey of aflatoxin M1 in local milk products reported many samples in excess of the European Union but not the WHO targets. The resulting press created panic, and resulted in a considerable outlay of funds for purchase of powdered milk from outside Africa by those able as well as powdered milk sent by the Ethiopia diaspora (14). In circumstances where corn is highly contaminated, feeding it to cattle and cows is vastly better than feeding it to children. Another concern is impugning the value of breast milk because of the presence of aflatoxin M1 (15).

Turna et al. (8) also provide lessons for the fully developed market economies. They demonstrate that the JECFA produced appropriate advice in 2001 and illustrate the importance of

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evidence-based decisions not informed by unnecessary precaution or ideology.

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