FOOD SAFETY IN FOOD SECURITY AND FOOD TRADE

Mycotoxin Food Safety Risk in Developing Countries

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A WIDESPREAD PROBLEM

Mycotoxins are produced by fungi, commonly known as mold. These toxins can develop during production, harvesting, or storage of grains, nuts, and other crops. Mycotoxins are among the most potent mutagenic and carcinogenic substances known. They pose chronic health risks: prolonged exposure through diet has been linked to cancer and kidney, liver, and immune-system disease. Because mycotoxins occur more frequently under tropical conditions and diets in many developing countries are more heavily concentrated in crops susceptible to mycotoxins, these chronic health risks are particularly prevalent in developing countries. In addition, mycotoxins can be present in livestock feed, reducing productivity in meat and dairy production. If these toxins find their way from feed into milk or meat, they become a food safety hazard in these products too.

Mycotoxins that pose human health risks include aflatoxins, deoxynivalenol (DON), fumonisins, ochratoxins, and ergot alkaloids. Some are produced before harvest (DON, ergot); some during and immediately following harvest (fumonisin, ochratoxin); and a few predominantly during storage (aflatoxin). Generally, tropical conditions such as high temperatures and moisture, monsoons, unseasonal rains during harvest, and flash floods lead to fungal proliferation and mycotoxins. Poor harvesting practices, improper storage, and less than optimal conditions during transport and marketing can also contribute to fungal growth and proliferation of mycotoxins.

Among the mycotoxins, aflatoxins raise the most concern. Aflatoxin B1 is found widely and in greater concentrations than other naturally occurring forms of aflatoxin throughout the world in foods such as maize, peanuts and peanut products, cottonseed and its extractions, and, to some extent, chilies, peppers, and pistachio nuts. Aflatoxin M1, a metabolite of aflatoxin B1, may occur in milk and its products if obtained from livestock that have ingested contaminated feed. Though high incidences of aflatoxin M1 have been reported in many parts of the world, the contamination levels usually have not been considered a serious public health problem.

Human exposure to levels of aflatoxins from nanograms to micrograms per day occurs through consumption of maize and peanuts, which are dietary staples in several tropical countries. The chronic incidence of aflatoxin in diets is evident from the presence of aflatoxin M1 in human breast milk in Ghana, Nigeria, Sierra Leone, Sudan, Thailand, and the United Arab Emirates, and in umbilical cord blood samples in Ghana, Kenya, Nigeria, and Sierra Leone. Frequent consumption of low levels of aflatoxin has been associated with chronic diseases like cancer.

DON occurs in grains such as wheat, barley, oats, rye, and maize. The total dietary intake of DON, mostly from wheat, is a potential health risk wherever wheat is consumed as a staple diet. Fumonisins are found worldwide, primarily in maize and its products and sorghum. Human exposure is highest in regions like Transkei, South Africa, where moldy, home-grown maize, damaged by insects, is often consumed. Ergot is caused by the fungus species *Claviceps* in pearl millet in India and East Africa, in sorghum wherever the crop is grown, and in wheat in the United States.

HEALTH IMPLICATIONS

Aflatoxins, DON, fumonisins, and ergot alkaloids have been implicated in acute mycotoxicosis (the result of consumption of high levels of mycotoxins over a short period of time) in both humans and farm animals. Outbreaks of aflatoxic hepatitis in humans have been reported in India, Kenya, and Malaysia. Epidemiological studies carried out in several parts of Africa and Asia indicate a correlation between exposure to aflatoxins and primary liver cancer. The risks associated with exposure to aflatoxins are enhanced by simultaneous exposure to the hepatitis B and possibly hepatitis C viruses. Recent studies carried out in West African countries, including Benin, The Gambia, and Togo, indicate chronic exposure of population groups and fetuses to dietary aflatoxins. Children exposed to aflatoxin may become stunted, underweight, and more susceptible to infectious diseases in childhood and later life. Many acute disease outbreaks from exposure to DON have been reported in China and India. Consumption of ergot in pearl millet and other grasses has resulted in acute nausea, vomiting, and dizziness in India and East African countries, and gangrene, a classic ergot poisoning symptom, in Ethiopia. Consumption of moldy sorghum or maize contaminated with fumonisin has been associated with an outbreak of disease in India. Fumonisin has also been associated with occurrences of esophageal and liver cancer and with the development of neural tube defects in the womb.

ECONOMIC LOSSES AND IMPACT ON INTERNATIONAL TRADE

Mycotoxin contamination in agricultural commodities has considerable economic implications. Losses from rejected shipments and lower prices for inferior quality can devastate developing-country export markets (see Briefs 6 and 15 for examples).

The toll of the effects on human health includes the cost of mortality—the cost of productive capacity lost when people die prematurely—and the cost of morbidity—losses resulting from hospitalization and the cost of health care services, both public and private. Finally, there is the intangible cost of pain, suffering, anxiety, and reduction of the quality of life.

Costs to farmers include reduced income from outright food or feed losses and lower selling prices for contaminated commodities. The economic impact on livestock production includes mortality as well as reductions in productivity, weight gain, feed efficiency, fertility, and ability to resist disease. Both quantity and quality of meat, milk, and egg production decreases. It is estimated that in Indonesia, the Philippines, and Thailand, 5 percent of the maize and peanuts produced are discarded because of fungi contamination. The annual cost of contamination due to aflatoxin and other molds in these countries in terms of product spoilage, human health effects, and losses in the poultry and pork sectors was calculated to be 477 million Australian dollars about a decade ago.

Any economic costs must be weighed against the costs of preventing mycotoxins through better production, harvesting, and storage practices. The latter costs are likely to be considerable. Member states of the African Groundnut Council—The Gambia, Mali, Niger, Nigeria, Senegal, and Sudan—have calculated the annual cost of implementing a program to reduce aflatoxin contamination at US$7.5 million.

PREVENTION

Intervention strategies to reduce exposure to mycotoxins can be undertaken at the individual or community level. Individuals can attempt to change their diets to avoid risky foods such as maize. Physical sorting of contaminated grains or nuts could also be useful. The use of the chemicals oltipraz and chlorophyllin could reduce exposure to aflatoxins.

At the community level, mycotoxin formation in crops can be limited before harvest through good agricultural practices such as rotating crops, irrigating to eliminate drought stress, controlling weeds, cultivating mold-resistant stocks, and introducing biocontrols such as nonmycotoxigenic fungal strains. Postharvest measures include drying rapidly by mechanical means and keeping crops dry. Sorting out contaminated nuts by physical means, sorting by color, and washing with water will also reduce mycotoxins. Chemical methods of detoxification include ammoniation processes.

Some successful measures to control mycotoxins that developing countries have undertaken during the last four decades include

- segregation of contaminated peanuts in Malawi,
- detoxification of peanut meal for export in Senegal,
- regulation of mycotoxins in animal feed according to the susceptibility of the animal species in Zimbabwe,
- selection of peanut varieties less susceptible to aflatoxin contamination in Burkina Faso, and
- improvement in produce-handling practices during the 1960s in Nigeria and the 1990s in The Gambia.

Many of these practices could be refined and adopted by other countries. However, such efforts are more likely to bring market rewards when there is an export or livestock feed market. Without price incentives, people are not likely to be motivated to reduce chronic risks that are not apparent to them.

REGULATION

Most importing countries regulate mycotoxins, thus affecting international trade. As Brief 6 points out, these stringent standards may have only modest implications for human health. The Food and Agriculture Organization of the United Nations (FAO)/ World Health Organization (WHO) Codex Alimentarius Commission concluded recently that populations with a low prevalence of hepatitis B infection are unlikely to achieve a dramatic decrease in liver cancer cases by imposing more stringent aflatoxin standards for foods, including milk. Hence, more stringent international aflatoxin regulatory standards are not considered an option by international organizations such as FAO and WHO.

CONCLUSIONS

Increased production of cereals will be needed in the future to satisfy growing food demand in developing countries and feed demand in the newly industrializing countries. Under these circumstances, occurrence of mycotoxins in agricultural commodities will continue to remain on the health and economic policy agenda. In parts of the world where food supplies are limited, drastic regulatory measures to lower mycotoxin standards would lead to food shortages and higher prices. The observation made during the outbreak of aflatoxin hepatitis in western India in 1974 that "starving to death today by not consuming contaminated food in order to live a better life tomorrow is not a practical option" is relevant even after 30 years. Thus, any preventive measures must be pro-poor, well-focused, and cost-effective. A focus on high-risk agricultural commodities during high-risk seasons in high-risk areas among high-risk population groups for selected mycotoxins would yield the greatest public health benefit. Monitoring human population groups for diseases attributable to mycotoxins, coupled with implementing appropriate prevention and control measures, including decontamination and detoxification, would ensure a food supply free from mycotoxins. Such investments would be returned many times over in better human and animal health and reduced economic losses. ■

For further reading see International Agency for Research on Cancer (IARC), *Some Traditional Herbal Medicines, Some Mycotoxins, Napthalene and Styrene*, IARC Monographs on the Evaluation of Carcinogenic Risks to Humans 82 (Lyon: IARC Press, 2002); World Health Organization (WHO), *Evaluation of Certain Mycotoxins in Food*, 56th Report of the Joint FAO/WHO Expert Committee on Food Additives, WHO Technical Report Series 906 (Geneva, 2002).

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