Risk of Mycotoxins in Sorghum and Millet Grains

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Summary

Mycotoxins in food are of growing health importance due to their association with a number of human and animal diseases. In humans, mycotoxins have been associated with neural tube defects, oesophageal and liver cancer. Additionally, mycotoxins affect productivity and trade with in the affected communities. The incidence and extent of mycotoxins in sorghum and millet is not well established. The conditions in tropical agricultural zones, which are the main production areas of sorghum and millet, favour the growth of moulds. Some species of the moulds *Fusarium* and *Aspergillus* found growing on millet and sorghum are known to produce mycotoxins. There are few reports of mycotoxin presence in millet and sorghum and the extent to which these toxins are produced in these grains is not well established. This paper explores the incidence, extent and health risk of mycotoxins in millet and sorghum.

Introduction

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Health risks associated with mycotoxins

Mycotoxins in grain foods are of growing health importance due to their association with a number of human and animal diseases. Mycotoxins are potent mutagenic and carcinogenic substances with both acute and chronic health risks. Long-term exposure through diet has been linked to liver and kidney cancer, as well as immuno suppression in both animals and humans. Although most of the evidence of mycotoxicity is derived from animal tests, mycotoxins pose a risk to humans too. Mycotoxins that pose human health risks include aflatoxins, deoxynivalenol (DON), fumonisins, ochratoxins, and ergot alkaloids. DON and ergot are produced before harvest; fumonisins and ochratoxin are produced during and/or immediately following harvest;

while aflatoxins are mainly produced during storage [3].

Aflatoxins, DON, and ergot alkaloids have been implicated in acute mycotoxicosis in both humans and farm animals. Outbreaks of aflatoxic hepatitis in humans have been reported in Kenya and India while acute disease outbreaks from exposure to DON have been reported in China and India [4]. One of the biggest acute cases of aflatoxin cases occurred in Kenya in 2004. Maize in several districts in the eastern and central provinces of Kenya was contaminated with aflatoxin producing moulds which resulted in 317 cases of poisoning and 125 deaths [5,6]. Subsequent smaller outbreaks of aflatoxin poisoning occurred in the same region in 2005 and 2006. Consumption of ergot in pearl millet and other grains has been reported to cause acute nausea, vomiting, and dizziness in India and East African countries, and gangrene, a classic ergot poisoning symptom, in Ethiopia [1].

In addition to acute toxicity, mycotoxins have also been implicated in long-term toxicity. Epidemiological studies carried out in South Africa indicate a correlation between exposure to mycotoxins and liver cancer. Fumonisins have been associated with occurrences of esophageal and liver cancer in Transkei Region in South Africa and China [7]. Fumonisins have also been associated with the development of neural tube defects [8]. It has been suggested that the risks associated with exposure to aflatoxins are enhanced by simultaneous exposure to malnutrition, HIV/AIDS and the hepatitis B and C viruses. In addition, children exposed to mycotoxins may become stunted, underweight, and more susceptible to infectious diseases in childhood and later life.

Table 1. Some moulds and the mycotoxins they produce in various grain foods

Mould	**Toxin**	**Nature of toxicity**	**Common carrier food**
Fusarium verticillioides, Fusarium proliferatum	Fumonisins	Liver and kidney tumours	Maize, Rice, Barley, mung beans, sorghum
Fusarium graminearum	Deoxynivalenol (vomitoxin)	Anorexia and vomiting	Wheat, barley, maize (less often in sorghum)
Claviceps fusiformis	Ergot		Pearl millet
Aspergillus flavus, Aspergillus parasiticus and Aspergillus nomis	Aflatoxins	Liver cancer	Peanut, maize, cotton seed
Penicillium verrucosum	Ochratoxin	Carcinogen	Most cereals

Adapted from [3].

Generally, tropical conditions such as high humidity, temperatures and rains during harvest favour mould growth and mycotoxins production. Poor harvesting practices, improper storage, and poor conditions during transport and marketing can also contribute to mould growth and production of mycotoxins [4]. Such conditions commonly prevail in Africa thus increasing the occurrence of mycotoxin producing moulds and subsequent exposure to these toxins. However, it should be noted that mycotoxins have also been reported in grain crops in the temperate parts of Europe and America [9,3]. Since mycotoxins occur frequently in tropical conditions, the diets of many people in tropical regions are mainly composed of grain crops susceptible to mycotoxins. With recurrent food shortages people are often forced to consume contaminated grain foods. Thus, the acute and chronic health risks of mycotoxicity are particularly prevalent in tropical regions with substantial health, trade and economic implications.

Mycotoxins in millets and sorghum

Mycotoxins are of critical importance in millet and sorghum since these grains form the staple food for the poor, who are also the most affected by malnutrition and HIV/AIDS. In developed countries, these grains especially sorghum is used as animal feed. Thus mycotoxins affect animal health and productivity as well as the safety of animal food products since some of the mycotoxins like aflatoxins have been reported in milk and milk products [3]. Although there is less consumption of sorghum and millet in developed countries, there is growing interest in these grains as a source of gluten-free breads. Therefore, the risk of mycotoxins in millets and sorghums is important for both developed and developing countries

Most research on mycotoxins has focused on major grain foods with little focus on non-traditional grains like millets and sorghum. Thus, there are few reports of mycotoxins in millets and sorghum. In a study carried out in Zimbabwe, fumonisins were reported in 0.2-3.7% of sorghum samples tested [10]. In another study in Burundi, fumonisins were found in sorghum and sorghum meal. Few of the millet and millet meal samples tested positive for fumonisins, though they contained the fumonisin-producing moulds [11]. In India, mycotoxin producing *Penicillium, Fusarium* and *Aspergillus* were isolated from sorghum and pearl millet [12], while ergot (*Claviceps fusiformis*) has been reported as a common field disease in pearl millet [13].

According to Rooney [14], sorghum does not develop significant levels of aflatoxin in the field prior to harvest, though it may contain *Aspergillus flavus* and other mould species. Aflatoxin production on sorghum seems to occur during improper storage of high moisture grains. Pearl millet also does not seem to produce significant levels of aflatoxins and fumonisins in the field either [14]. The production of mycotoxins in these grains seems to be associated with poor handling and storage methods. In addition, it is also possible that these grains are resistant to mycotoxin producing moulds when still in the field.

Conclusion

The occurrence of mycotoxins in sorghum and millets pose a potential health risk which is hitherto not well established. The presence of mycotoxins in sorghum and millets seems to depend on a number of factors including grain resistance, time of contamination and post-harvest handling and storage conditions. Given the growing contribution of sorghum and millets to diets, it is imperative that the incidence, extent and risk of mycotoxins in sorghum and millets be studied in order to design mitigation strategies. In the meantime, strategies such as prevention, decontamination and breeding for resistance can be used to mitigate the health risks associated with mycotoxins.

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