



February 2018

REF. No.: WHO/NHM/FOS/RAM/18.3

Department of Food Safety and Zoonoses

Co-exposure of fumonisins with aflatoxins

There is concern about increased health risks from co-exposure to the two types of mycotoxins

Fumonisin and aflatoxin are poisonous substances produced by fungi, commonly known as moulds, of *Fusarium* and *Aspergillus* species, respectively. While aflatoxins are known to cause cancer of the liver in humans, fumonisins are thought to be possible cancer promoters of aflatoxin carcinogenicity. There is some evidence and concern that additive or synergistic (i.e. more than additive) actions occur when both types of mycotoxins are present, potentially increasing carcinogenicity.

Of the many types of aflatoxins, four – aflatoxins B₁ (AFB₁), B₂, G₁ and G₂ – are particularly dangerous to humans and animals. Of the many types of fumonisins known, fumonisins B₁ (FB₁), B₂ and B₃ are the major forms found in food.

Both mycotoxins are frequent contaminants of cereals

Fumonisin and aflatoxin are both frequent contaminants of maize and to a lesser extent, of rice, sorghum, wheat, and cereal-based foods prepared from these commodities. Aflatoxins, but not fumonisins, are also common contaminants of ground nuts (i.e. peanuts) and tree nuts (e.g. almonds, pistachios, Brazil nuts). The toxins occur worldwide. Exposure to both mycotoxins is likely in areas where these foods are routinely consumed. Co-exposure can either occur from the same food being contaminated with both mycotoxins, or within the diet/meal from different foods each contaminated with one or the other. Many methods are available for detecting aflatoxins and fumonisins in crops, including various types of chromatography, electrophoresis, and immunosorbent assay.

The degree of co-occurrence of aflatoxins and fumonisins can be influenced by many factors, including type of commodity, region, time of sampling, storage, food preparation and processing. A recent evaluation (Joint FAO/WHO Expert Committee on Food Additives (JECFA), 2016) of co-occurrence of aflatoxins and fumonisins in foods for human consumption found co-occurrence in 1.7% of around 5000 samples submitted to the GEMS/Food contaminants database between 2011 and 2016. For individual samples, co-occurrence was found for 5.5% of maize samples, 4.2% of cereals and cereal-based products, 2.8% of bread and other cooked cereal products, 1.4% of sorghum, and 0.4% of cereal-based foods for infants and young children.

The role of aflatoxin–fumonisin interactions in human disease is not yet understood

Aflatoxins are among the most carcinogenic and mutagenic (DNA damaging) substances known, and they also cause immunosuppression and possibly stunting, while acute poisoning can also occur at high contamination levels, and can be life threatening. Fumonisin is associated with a wide range of health effects in animals, especially on the liver and kidney, although data for the health effects of fumonisins in humans are as yet limited.

The health concerns of co-occurrence include possible antagonistic, additive or synergistic effects between the two types of toxin. Evidence from laboratory animals, and from *in vitro* studies, suggests an additive or synergistic effect of fumonisin and aflatoxin co-exposure on the development of precancerous lesions or liver cancer, but currently there are few data to support co-exposure as a contributing factor in human disease. No study has yet shown that co-occurrence of fumonisin and aflatoxin exposures in humans resulted in increased cancer risk. In animals however, changes are seen in the number of cells associated with pre-cancerous lesions in the liver (apoptosis, GST-P⁺ foci, regenerative hyperplasia), and it is thought that this may promote the tumour-forming potential of the DNA damage initiated by AFB₁. In addition, animal models have shown increased incidence of liver cancer or pre-cancerous lesions following sequential exposure to both mycotoxins and other known liver carcinogens.

Other concerns include possible interaction between aflatoxins and fumonisins in childhood stunting. There are few data, but two prospective epidemiological studies do not support this hypothesis, although both aflatoxin and fumonisin exposure individually have been correlated with stunting in children.

Thus there is not yet adequate information on aflatoxin–fumonisin interactions to facilitate an understanding of the role and extent of co-exposure as a contributing factor in human disease.

To date there are few reports on dietary co-exposure

To estimate human exposure to mycotoxins, urinary analytical methods are increasingly being used. Although there are methods available to measure the concentration of more than five mycotoxin biomarkers at the same time, few studies have provided any information on the status of co-occurrence. In only two countries (Guatemala and the United Republic of Tanzania) has co-exposure been confirmed using urinary or plasma exposure biomarkers of FB₁ and AFB₁. These countries belong to two GEMS/Food clusters (G05 – mainly South and Central America, and G13 – mostly sub-Saharan African countries) that have high dietary exposure to both AFB₁ and FB₁ according to the international estimates provided by JECFA.

Regarding reported co-exposure in infants, one study, in the United Republic of Tanzania, showed detectable concentrations of FB₁ in human breast milk. This indicates the potential for co-exposure to aflatoxins and fumonisins for breastfed infants. Infants can also be co-exposed to aflatoxins and fumonisins through infant formula foods, which are largely cereal based. AFB₁ and FB₁ have been detected in such infant foods.

Co-occurrence can be controlled both pre and post harvest

Both pre and post-harvest control measures are available. Better procedures are required for pre-harvest control, but, particularly for aflatoxins, biological control is showing promise; for fumonisins, a variety of pre-harvest control methods are still under development including transgenic crops and diverse biological methods.



Mycotoxin contaminated bread

Fumonisin production in storage is unlikely, whereas, aflatoxin production in storage is a potential problem in poorly stored maize. For control during storage of crops, interventions include measures to address storage conditions such as moisture, temperature, mechanical or insect damage, aeration, all of which influence contamination and toxin production by *Aspergillus* mould.

WHO supports countries in controlling fumonisins and aflatoxins

WHO, in collaboration with FAO, evaluates the science and develops risk assessments to define safe exposure levels. Based on these risk assessments, maximum levels for fumonisins and aflatoxins in different foods are recommended. These form the basis for national regulations to limit contamination.

Since aflatoxins were first noted in the 1960s, and fumonisins in the 1980s, they have several times been the subject of toxicological evaluations and dietary exposure assessments by the Joint FAO/WHO Expert Committee on Food Additives (JECFA). These evaluations inform the Codex Alimentarius Commission¹ which has worked, since 1963, to create harmonized international food safety standards to protect the health of consumers and ensure fair trade practices.

Codex standards set the maximum levels for contaminants and natural toxins such as fumonisins and aflatoxins in food and are the reference for the international trade in food, so that consumers everywhere can be confident that the food they buy meets agreed standards for safety and quality, no matter where it was produced. To prevent and reduce the risk of fumonisins and aflatoxins in food and feed, Codex has also established codes of practice, which describe preventive measures.

In support of this work, WHO collects food contamination data from nationally recognized institutions through the Food Contamination Monitoring and Assessment Programme of the WHO Global Environment Monitoring System, commonly known as GEMS/Food². The GEMS/Food contaminants database informs governments, the Codex Alimentarius Commission and other relevant institutions, as well as the public, on levels and trends of contaminants in food.

The GEMS/Food programme has also developed a Consumption Cluster Diets database, which provides an overview of food consumption patterns worldwide, through 17 dietary patterns (based on population food choices) covering more than 180 countries. These estimates, together with reported contamination levels, allow assessment of the potential exposure of populations to contaminants such as fumonisins and aflatoxins in food. The consumption diets are based on Food Balance Sheet (FBS) data collected by FAO, and are routinely used by international risk assessment bodies.

National authorities are developing regulations to limit contamination

Exposure to fumonisins and aflatoxins needs to be kept as low as possible to protect the consumer. Many countries have regulations governing fumonisins and aflatoxins in food, and most have maximum permitted or recommended levels for different foodstuffs. Both fumonisins and aflatoxins damage health and business opportunities, and importing countries are imposing increasingly more stringent regulations.

The consumers can do

As fumonisins and aflatoxins do not always occur in the same food, WHO has developed specific recommendations on how to avoid each of these mycotoxins in the diet. More detailed information on how to reduce the risk of exposure to fumonisins and aflatoxins, and on the food sources and effects of mycotoxins in the diet or in animal feed, can be found in the individual food safety digests on aflatoxins and on fumonisins.

¹ a joint intergovernmental body of FAO and WHO with 187 member states and one member organization (EU): <http://www.fao.org/fao-who-codexalimentarius/en/>

² http://www.who.int/foodsafety/areas_work/chemical-risks/gems-food/en/

Further reading (references)

Evaluation of certain contaminants in food (Eighty-third report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No.1002, 2017.

Evaluation of certain food additives and contaminants (Seventy-fourth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 966, 2011

Evaluation of certain food additives and contaminants (Sixty-eighth report of the Joint FAO/WHO Expert Committee on Food Additives). WHO Technical Report Series, No. 947, 2007.

JECFA report and additional information are available at www.who.int/foodsafety/areas_work/chemical-risks/en/