Stored Grain

Toxigenic Fungi

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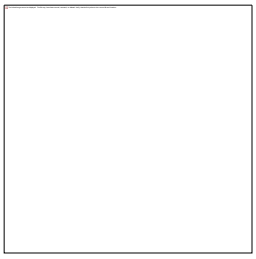

Three genera of fungi, *Aspergillus, Penicillium,* and *Fusarium (Gibberella)* are most frequently involved with cases of mycotoxin contamination in corn, small grains, cottonseed and soybeans (Table 1). *Aspergillus flavus* produces aflatoxins in starchy cereal grains (e.g., corn, wheat, sorghum, oats, barley, millet, rice) and mold growth and mycotoxin production essentially starts at a moisture content of about 18% (0.85 aw, equilibrium with 85% relative humidity), and at temperatures of 54^{o} to 108 ^{o}F (13° to 42°C) with optimum growth at 81^{o} to 86°F (25° to 30°C). The critical moisture content for growth of *A. flavus* in soybeans is 15 to 15.5% and for peanuts 8 to 9%. The upper limit of moisture for growth of *A. flavus* and aflatoxin production is about 30%. *A. flavus* will grow slowly below 54^{o}F (13^{o}C), and most rapidly at 98°F (37°C) but will not produce aflatoxins at temperatures below 54 °F (13°C) or above 108°F (42^{o}C). Under optimum conditions for growth, low levels of aflatoxins can be produced by *A. flavus* within 24 hours and a biologically significant amount can be produced within a few days.

Other toxigenic fungi grow on grain at moisture contents of 17 to 40% and a wide range of temperatures from below freezing (<0^{o}C) for some species of *Penicillium* to over 131°F (55°C) for some species of *Aspergillus*. The quality of the grain and its suitability for storage are adversely affected by (1) a high moisture content, (2) physical damage to the kernels, and (3) the extent to which storage fungi have invaded the seed before the grain goes into storage.

Toxigenic fungi may grow under a given set of conditions but do not necessarily produce mycotoxins. The substrate is important. For example, *A. flavus* grows equally well on peanuts and soybeans but produces more aflatoxins when growing on peanuts than when growing on soybeans. The risk factors for preharvest production of aflatoxins are warm-to-hot, humid conditions, drought-stressed and insect-damaged

plants; these conditions are the most common in the southeastern United States. Post harvest aflatoxin production can occur anywhere.

Table 1. Major Mycotoxins and Toxin-Producing Fungi from Corn, Cereal, Soybeans, Peanuts, and Other Pro
and Some of their Effects on Animals.

Toxin or Syndrome	***Fungal source***	***Feeds or foods affected***	***Possible effects on animals***
Aspergillus *Toxins- (primarily) Aflatoxins B_1, B_2, G_1, and G_2 (B_{2a}, G_{2a}, M_1, and M_2 are metabolites and seldom present in grain; M_1 and M_2 are important contaminants in milk)*	Aspergillus flavus and A. parasiticus	*Cereal Grains, peanuts, soybeans, and other foods*	*Hepatotoxin; carcinogenic; reduced gr rate; hemorrhagic enteritis; suppressio natural immunity to infection; decrease production of meat, milk and eggs, pulmonary mycotoxicosis*
Ochraoxins (nephrotoxins)	Aspergillus alutaceaus var. alutaceus (ochraceus) *and* Penicillium viridicatum	*Cereal grains*	*Toxic to kidneys and liver; abortion; po feed conversion, reduced growth rate, general unthriftiness; reduced immunit infection*
Sterigmatocystin	Aspergillus nidulellus, A. glaucus, A. sydowii A. versicolor and Bipolaris sorokiniiana	*Cereal grains*	*Toxemia; carcinogenic, hepatotoxic*
Termorgenic toxin	Aspergillus flavus, Aspergillus terrus, Penicillium cyclopium, *and* P. palitans	*Cereal grains, soybeans, peanuts, and other food feeds, etc.*	*Tremors and convulsions, death*
Penicillum Toxins (primarily) Luteoshyrin	Penicillium islandicum	*Rice*	*Hepatotoxic, tremors and convulsions*
Patulin	Penicillium urticae, P. expansum, P. clavirome, *and Aspergillus clavatus*	*Cereal grains, apple products*	*Hemorrhages of lung and brain; edema toxic to kidneys; possibly carcinogenic*
Rubratoxin	Penicillium rubrum		*Liver damage, nephrotoxic and hemor*
Citrinin	Penicillium citrinum		*Kidney damage*
Penicillic Acid	Penicillium viridicatum and several other Penicillium sp.	*Cereal grains*	*Similar to ochratoxin*
Ergot Toxins Ergopeptines	Claviceps purpurea	*Cereal Grains*	*Vasoconstriction, loss of extremities (e tail, fee, etc.), skin necrosis, agalactia*
Ergovaline	Neotyphodium (Acremonium) and Epichloe sp.	*Fescue*	*Reduced weight gain, abortion, poor survivability of offspring, fescue foot*
Fusarium Toxins			
Zearalenone (Estrogenic syndrome) Zearalenol	Fusarium graminearum, F. colmorum, F.equiseti	*Cereal grains, soybeans*	*Hyperestrogenism, infertility, stunting, and even death*
Emetic or feed refusal Factor, (Vomitoxin) Deoxynivalenol or DON	Fusarium graminearum *(sexual state),* Gibberella zeae*),* F. culmorum	*Cereal Grains*	*Food refusal by swine, cats, dogs; reduction in weight gain*

Other trichothecenes (T-2, HT-2, Monoacetoxyscripenol or MAS, Diactoxyscripenol or DAS)	Fusarium graminearum, F. equiseti, F. poae, F. acuminatum, F. sambucinum and F. sporotrichoides	*Cereal grains, soybeans, potato*	*Severe inflammation of gastrointestinal tract and possible hemorrhage; edema; vomiting And diarrhea; infertility; degeneration of bone marrow; death; reduced weight gain; slow grow sterility, abortion*
Fumonishin B^1, B^2	F. verticillioides, F. proliferatum	*Corn*	*Leukoencephalomalacia "moldy corn disease" in horses, pulmonary edema swine, neural tube defects and esopha cancer in humans*

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