9-1-1973

Aflatoxin-Mold Produced Hazard in Grain: Its Detection and Prevention

John Tuite

Donald H. Scott

on the farm

Control PLANT DISEASES

BP-5-21
September 1973

AFLATOXIN-MOLD PRODUCED HAZARD IN GRAIN: ITS DETECTION AND PREVENTION

Molds can attack grain in the field and in storage under certain environmental conditions, and a few of them while growing can produce substances harmful to man and animals. These substances are called mycotoxins, and one of the most important of them is aflatoxin produced by a yellow-green fungus named Aspergillus flavus.

Aflatoxin is a hazard to the grain handler, processor and consumer because of its extreme toxicity. Aflatoxin is 600 times more toxic than lead arsenate. It readily produces cancer in several test animals. The actual association, however, with human disease in the United States is unknown. It has been incriminated in human liver cancer in certain parts of the world where foods moldy with A. flavus are routinely consumed. The aflatoxin hazard to the processor and handler is primarily financial because of possible governmental seizure of contaminated grain. Seized corn must be destroyed or at least not sold. There are at present no alternative uses for contaminated grain. Financial losses may also be incurred by death or unthriftiness of animals. Outbreaks of aflatoxin have occurred mostly in farm grown trout, turkeys, ducklings, swine and cattle. Often the characteristic internal feature of aflatoxin poisoning is a diseased liver with loss of color or discoloration. A correct diagnosis is usually only possible with a microscopic examination of tissue by a veterinary pathologist accompanied by significant levels of aflatoxin in the feed.

Time of Invasion and Contamination

Aspergillus flavus, in the corn belt, probably invades only after the corn is harvested, although kernels damaged by mites, insects or birds may permit limited field infection. Possibly in the more southerly areas of the United States more field invasion occurs.

Storage invasion - The greater amount of invasion by A. flavus is in storage. Invasion may occur when corn is stored at temperatures over 75-80 degrees F and 18 per cent moisture or above for more than 2 or 3 days. The fungus can produce considerable amounts of aflatoxin in a very short time at these temperatures and moisture levels, particularly on damaged kernels. One or two kernels or kernel fragments containing aflatoxin in a bushel of corn is sufficient to give a level in excess of 20 parts per billion (ppb) which is the condemnable level for food use.

How Aflatoxin is Detected

Visual detection (Black Light Test) - Usually aflatoxin production is associated with a chemical produced by A. flavus that fluoresces a bright green yellow (BGY) when exposed to long wave ultraviolet light (so-called Black Light*). Some confusion may occur since fluorescent compounds occur naturally in white corn, soybean and

*The proper ultraviolet light can be provided by a General Electric BLB fluorescent lamp or a black light manufactured by Ultra-violet Products, Inc., San Gabriel, CA. The latter gives a more intense light, but it is much more expensive. They are available from most scientific supply or grain equipment companies. Do not use a mineralight or short wave ultraviolet light.

various plant parts, and some are produced by other microorganisms. BGY is also not produced in seed killed by high temperature drying. Therefore, reference standards sealed in ampules are available from USDA laboratories for checking fluorescence.** Grain screenings provide the most suitable material for observation of BGY as the compound is often found in broken pieces of corn, particularly the starchy endosperm. Very little BGY fluorescence is seen in the germ. More numbers of positive samples are obtained if the sample (2 lbs. or more) is coarsely ground prior to viewing, but this technique may increase the number of false positives. The Black Light test is a fast presumptive and sensitive test. Chemical tests are necessary to confirm the presence of aflatoxin.

Chemical tests - One test is the millicolumn method that tells if the corn contains more than 5 to 10 ppb of toxin. This technique is relatively quick, perhaps 20 to 30 minutes long and does not require much equipment. For an accurate determination of aflatoxin in corn a more lengthy chemical test is required. This is usually performed by industry research laboratories and by commercial testing laboratories. The latter charge from $10 to $25 per sample depending upon the numbers of samples submitted. Details of the technique is available upon request from Purdue and the USDA lab at Peoria.

Preventing Contamination

Preventing all mold growth is the only sure way of preventing aflatoxin production in stored corn even though only one fungus, A. flavus, probably produces the toxin. Growth of other molds or insects may quickly increase the moistures and temperatures of stored grain to that required by A. flavus. To prevent mold growth in long term storage (more than 6 months), corn should be stored below 14 per cent and preferably aerated continuously at 1/20 to 1/30 CFM/bu. to prevent moisture migration. Shelled corn of 16 to 18 per cent should be at or below freezing if storage is longer than a month. Corn stored at initial moistures of 21 per cent will dry sufficiently in the fall and late winter with proper continuous aeration (about 1/2 CFM/bu.) to be at safe moistures by spring. However, aeration systems are a definite hazard if the grain is above 23 per cent and warm temperatures prevail. The drying rate with unheated air is often not faster than the growth rate of A. flavus. In fact these conditions of high moisture, good air supply and warm temperatures are optimum for aflatoxin production. Aflatoxin could be produced in about 2 days under such conditions.

Other methods of safely storing corn are: 1) storage of ear corn in well-ventilated cribs at initial moistures of no greater than 22 per cent. 2) Organic acid preservation has worked well so long as the acids are uniformly applied at the recommended rates and treated grain is not mixed or layered on untreated grain; metal corrosion and costs are factors to be considered. 3) Sealed storage of high moisture corn has been successful for many years with good management. It requires well-sealed structures and corn at 22 to 35 per cent for best results. Some prefer to grind the corn to lessen initial trapping of air. If the corn is being fed out at a slow rate in the spring, molds may develop in the nearly empty bins. Also corn can mold if left in the feeder for more than 2 days.

Once aflatoxin has been found in grain at condemnation levels, little can be done but to destroy the grain. There are no economic methods of removing or destroying the very stable toxin, although ammonia under pressure has been used in cottonseed meal. Blending may compound economic losses, since FDA will seize any grain purposely mixed with contaminated grain.

**United States Department of Agriculture, 1815 North University Street, Peoria, IL 61604.

******

Prepared by John Tuite and Donald H. Scott, plant pathologists.