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Molds (or fungus) are commonly found in the environment, with more than 200,000 species recognized at present. About 60 species of mold have been determined to be harmful to man and animals. The presence of molds in feed grains may result in problems and economic losses for swine producers. Molds utilize nutrients present in infected grains to lower the available energy, vitamin E and carotene levels in these grains. Certain groups of molds may produce chemical metabolites, called mycotoxins, that are detrimental to the growth and reproductive function of swine, if ingested.

CONDITIONS FAVORING MOLD GROWTH AND MYCOTOXIN PRODUCTION

The optimum conditions for mold growth are quite variable. However, several basic requirements must be met for molds to grow in field or stored grains: (1) a carbohydrate source that is readily available, (2) the moisture level in the grain must exceed 14% with at least 70% relative humidity, (3) a temperature that is adequate for growth and(or) mycotoxin production (may range from 32 to 77^{o}F) and (4) the presence of oxygen.

Mold infections in field grains generally occur during the flower or silk stage. These infections are difficult to control particularly if periods of rainfall persist around harvest. Other factors may enhance mold growth in stored or unharvested grains. Fungal invasion may increase if the seed coat is damaged by insects or during handling. Drought conditions, failure to dry corn soon after harvest and storage of high moisture grains (without preservatives) in the presence of oxygen may also increase mold growth and mycotoxin production.

MYCOTOXINS OF CONCERN

Mycotoxins are typically discussed individually with respect to their toxicity to swine. However, infection by a single specie of mold may produce several mycotoxins that work synergistically to produce toxicosis in the animal following ingestion of the infected grain. A number of species may also produce the same or related mycotoxins. Several common mycotoxins and their effects on swine are summarized in Table 1.

Zearalenone and vomitotoxin. Currently, the mycotoxin producing fungus of greatest concern to the midwest belongs to the genus Fusarium. These molds typically infect corn and produce "scab" in wheat, oats and barley. Optimum growth in corn occurs when rainfall and temperatures greater than 70 F are prevelant during silking, followed by a short drying season during the fall. High Fusaria infections may also be associated with high corn-borer infestations. Optimal growth occurs at temperatures of 68 to 77°F, but mycotoxin production is stimulated at temperatures of 59°F and below. Mechanical damage to the grain and improper storage conditions for corn having greater than 15% moisture are also conducive to mold growth.

Fusaria may produce a number of mycotoxins, two of which are currently considered to be of economic importance: zearalenone and vomitotoxin. Swine are particularly sensitive to zearalenone which is an estrogen-like compound. Less than 10 ppm zearalenone in the diet may produce estrogenism in pre-puberal gilts characterized by reddening and swelling of the vulva and mammary glands, increased uterine weight and thickening of the uterine wall. Prebreeding and gestation diets containing zearalenone will produce pseudopregnancy or impair development of the uterus, placental membrane and fetuses in pregnant gilts. Zearalenone lowers circulating testosterone levels, decreases libido and delays development of sexual behavior in young boars, but does not affect sperm production.

Vomitotoxin is generally present in association with zearalenone in Fusarium infected grains. Vomitotoxin typically causes feed refusal and vomiting when present in diets fed to young pigs at low (1 ppm) and high (20 ppm) concentrations, respectively. Vomitotoxin may also reduce fetal weight in pregnant gilts. Abnormal steroid levels, embryonic death and loss of normal estrus cyclicity result when both vomitotoxin and zearalenone are present in diets fed to gestating sows.

Aflatoxins. Another group of mycotoxins of increased interest, are the aflatoxins, produced by Aspergillus flavus and A. parasiticus. Aflatoxins are a group of similar or related toxins typically associated with improper storage of corn. The greatest incidence of aflatoxins occur in warm humid regions with few reported problems in the midwest.

Diets containing aflatoxins will reduce disease resistance and growth rate in growing swine. Severe cases result in death. Aflatoxins cause feed refusal, and gastric ulcerations in sows fed diets containing contaminated grains. Aflatoxins have not been associated with reproductive problems in breeding swine. However, no safe levels have been determined.

Ochratoxin A and Citrinin. Penicillium molds may produce several mycotoxins, including ochratoxin A and citrinin. Penicillium molds have been reported most frequently in Scandinavian countries, but can occur in Canada and the United States. Mold growth is typically associated with late harvested barley.

Ergot. Clavicips Rurpurea is a parasitic fungus that is most commonly found on rye but may also infest wheat, barleyand triticale. The fruiting bodies (sclerotia) of C. rurpurea contain alkaloids which are toxic to animals and humans once ingested. This toxicity, called ergot, is reported frequently in the midwest.

The most severe symptoms of ergot toxicity occur when swine are fed diets containing high levels of ergot for an extended period of time. Severe ergotism decreases blood flow to the body extremities (tail, legs, etc.) causing deprived tissues to die and ultimately become gangrenous. Ergotism also results in uterine contractions and abortion in pregnant animals. Sows and gilts fed diets containing ergot have shortened gestation periods and farrow pigs that are small and weak. A large percentage of these pigs typically die soon after birth due to their weakened state. Ergot restricts mammary gland development and suppresses milk production in sows, which contributes to the high piglet mortality.

PREVENTION AND GUIDELINES

The most effective treatment against mold growth and mycotoxin production is prevention. However, prevention of field infestations is difficult at best and probably not feasible. Mold growth may be controlled in stored grains through use of sound grain storage and handling practices. High moisture grains present the greatest problem. Storing high moisture grains in air tight structures or pre-treatment with organic acids such as propionic acid prior to storage in conventional structures should limit mold growth and mycotoxin production.

Extreme caution should be used any time swine are fed grains or mixed feeds thought to be moldy. However, not all molds produce mycotoxins and some produce mycotoxins only under certain conditions. Thus, the following steps should be followed before making a decision to feed or discard a suspect grain:

1. Feed the suspect grain to a few healthy growing pigs that are not sexually mature (i.e. non-cycling gilts). Be observant for any deleterious effects.
2. Blend the suspect grain or feed with sound grain to dilute the concentration of mycotoxins.
3. Never feed moldy grain to the breeding herd or replacement gilts because zearalenone and ergot are the two mycotoxins most likely to occur in the midwest.
4. If mycotoxicosis is suspected, consult a veterinarian. Many infectious diseases have symptoms that are similar to those produced by mycotoxins. These should be ruled out before further action is taken.
5. Evidence of mold either by evaluation or various testing procedures does not mean mycotoxins are present.

Remember mycotoxins are difficult to detect analytically due to the large number of possibilities, limited assay sensitivity in some cases and difficulty in obtaining a representative sample. Molds do not grow uniformly in a quantity of grain which adds to the problem of obtaining good samples.

Should mycotoxin analysis be necessary:

1. Consult a veterinarian or expert as to which specific mycotoxin to screen for.
2. Sample the bin or load in several locations. Mold growth will most likely be found in areas where fines, screenings or damaged grain are concentrated.

Table 1. Effects of Some Mycotoxins in Swine

Mold	Mycotoxin	Most prevalent Occurrence	grain affected	Toxicity symptoms in swine
Fusarium	Zearalenone	Midwest U.S.	Corn (also "scabby" wheat, barley and oats)	Swollen vulva and teats in immature gilts, pseudopregnancy in sows, decreased libido in boars
	Vomitotoxin	Midwest U.S.	Corn, wheat, barley and oats	Feed refusal and vomiting
Aspergillus	Aflatoxin	Southeast U.S.	Stored corn	Reduced growth, reduced disease resistance, death
Penicillium	Ochratoxin A	Primarily Scandinavian countries, some U.S. and Canada	Corn, barley, sorghum	Kidney lesions, kidney disease
	Citrinin	Same as Ochratoxin	Same as Ochratoxin	Same as Ochratoxin
Claviceps	Ergot	U.S. world-wide	Wheat, rye, barley, oats, and triticale	Retarded growth, poor rebreeding, decreased milk production, high baby pig mortality after birth