

The role of mycotoxins in pig reproduction

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Mycotoxins are toxic products produced by the metabolic processes of fungi. The four main genera of mycotoxin producing fungi are *Aspergillus*, *Fusarium*, *Penicillium* and *Claviceps*.

Mould growth occurs at various stages of the production chain and mycotoxins can invade the grains before harvest while the crop is standing in the fields or as a consequence of mould growth during ingredient or feed storage at the mill and on the farm.

These fungi can contaminate various ingredients such as maize, wheat, barley, millet, peanuts, peas and oily feedstuffs. The production of mycotoxins is enhanced by factors such as the moisture content of the substrate (>10-20%), the relative humidity (>70%), temperature (0-50°C depending on fungal species) and the availability of oxygen.

Mycotoxins can cause toxic effects or mycotoxicoses and the symptoms seen depend on the type and level of mycotoxin as well as host species, sex, environment, nutritional status and the presence of other toxic entities.

Mycotoxicoses are not transmissible between animals and when several animals or farms are affected it is because of a common contaminated feed source.

Difficult to diagnose

Diagnosis is difficult because of the varied effects of various mycotoxins and often there are only non-specific presenting signs such as immunosuppression, scour, haemorrhages and/or reduced performance.

However, it should be noted that the presence of the fungi per se does not automatically imply mycotoxin production or a problem. Likewise, a combination of mycotoxins could well be present.

The global distribution of mycotoxins shows geographical patterns with, for example, *Aspergillus* related problems being most common in tropical and subtropical regions and *Fusarium* and *Penicillium* problems most common in Europe and North America.

From an animal production point of view there are five important classes of mycotoxins, namely, trichothecenes, zearalenone, ochratoxins, aflatoxins and fumonisins.

Reproductive mycotoxicoses are those that are associated with reproductive failure and depressed reproductive performance. The three most important types of mycotoxins in terms of pig reproduction are those produced by *Aspergillus* Spp., *Fusarium* Spp. and *Claviceps* Spp.

The main mycotoxins associated with reproductive problems are zearalenone, ergot alkaloids and the trichothecene, T-2 (see Table 1).

Zearalenone is a mycotoxin produced by *Fusarium* Spp, especially *F. graminearum* and
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Table 1. Mycotoxins that affect pig reproduction (Osweiler, 9th edition of Diseases of Swine).

Mycotoxin	Most affected	Clinical signs	Lesions	Diagnosis	Therapy/prevention	Residues
Aflatoxin	Piglets	Depressed growth, immune dysfunction	Hepatic necrosis, bile duct hyperplasia	Aflatoxin in feed, metabolites in tissues	Vitamin E, selenium and aluminosilicate	Liver for < 3 weeks
T-2 toxin	Sows and growers	Feed refusal, scour, oral ulcers, immune suppression	Oral and gastric ulcers, lymphoid and thymic depletion	Histological lesions of ulceration, lymphopenia and leucopenia Feed analysis	Change feed. Treat for ulcers and scour	Unlikely to occur
DON	Sows	Feed refusal, reduced growth	Weight loss	DON > 1 ppm	Change feed	No residues
Ergot	Sows and piglets	Agalactia with piglet starvation, peripheral gangrene	Piglet starvation peripheral gangrene	Ergot bodies or alkaloids in urine or diet. Perivascular lesions	Avoid ergot in grain	Brief presence. Not likely to be significant
Zearalenone	Prepubertal gilts, cycling sows and young boars	Hyperoestrogenism in young gilts, pseudopregnancy, delayed cycling, early embryonic death, reduced libido	Vulvovaginitis, vaginal keratinisation	Histology of vaginal keratinisation, elevated serum progesterone and zearalenone found in feed.	Change feed. Treat gilts for prolapses. Administer 10mg PGF ₂ to pseudopregnant sows	Rapidly excrete in urine. Low probability of residues

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F. culmorum and maize and wheat are the most frequently affected. A high relative humidity during storage favours production of this mycotoxin. Zearalenone induces oestrogenic effects that cause anabolic and reproductive effects. Pigs are more susceptible to this mycotoxin than other species and suffer hyperoestrogenic effects including anoestrus, abortion, increased embryonic and foetal deaths, failure to respond to PGF2 and an increased incidence of stillborn and splay legged piglets. Gilts are more sensitive to zearalenone than sows.

In gilts low doses of zearalenone (1.5-2.0ppm) result in a thickening and swelling of the vaginal and vulval wall, an increased uterine mass and atrophic ovaries (higher doses are required in sows). The standing reflex does not occur.

These changes occur three to seven days after receipt of the mycotoxin and cease a couple of weeks after withdrawal. Higher doses of zearalenone (3ppm) will cause anoestrus in gilts and 2ppm zearalenone fed for 45-90 days can induce early (70 days) puberty. In these gilts the first heats are usually infertile.

In cycling sows 5-10ppm zearalenone in feed fed after weaning causes prolonged cycles or, even, anoestrus. There have been many studies on the possible effects of zearalenone on pregnancy.

Feeding of levels >3ppm has been associated with smaller litters and mummification. When fed late in gestation day old piglets with swollen vulvas can be seen.

Zearalenone appears to have no effect on ovulation or implanted embryos.

Experimental administration of 4ppm zearalenone to sows throughout gestation results in reduced foetal weights and a loss of litter uniformity. There is some evidence to suggest that feeding zearalenone to lactating sows can affect the suckling litter.

Young boars given feed contaminated with zearalenone (up to 600ppm for 6-15 weeks) have been shown to have smaller testicles

and a temporary inhibition of spermatogenesis has been seen, which was reversible on the withdrawal of contaminated feed. There is also research that shows an adverse effect of zearalenone on libido in boars and, recently, this mycotoxin has been shown to reduce the ability of spermatozoa to bind to the zona pellucida of the oocyte.

The modern cleaning and storage of grains has meant that problems associated with the ergot alkaloids that are produced by *Claviceps* Spp. are now very rare. The ergot alkaloids affect reproductive performance and signs include oxytocin resistant agalactia, small litters, premature farrowing, mummification, repeat oestrus, metritis and mastitis. Ergot intoxication also has other non-reproductive signs such as dry gangrene of the tail, ears and hooves of unweaned piglets.

Trichothecenes

The trichothecenes which are produced by *Fusarium* Spp. include desoxynivalenol and T-2, with the latter being the most important for the reproductive system.

T-2 is produced by *Fusarium tricinctum* and is one of the most potent mycotoxins found in wheat, maize, rye and soybeans.

T-2 fed at 1-2ppm to sows in the last third of gestation had an inhibitory effect on the ovaries, while in another study feeding sows with feed contaminated with 12ppm T-2 for 220 days resulted in repeat breeders, small litters and underweight piglets.

Desoxynivalenol's effects on reproduction in pigs are thought to be due to indirect effects of reduced feed intake and subsequent liver and spleen dysfunction rather than to any direct effect on the reproductive system.

Aflatoxins are mainly produced by *Aspergillus flavus* and *A. parasiticus* and are present in many feedstuffs. Pigs are highly susceptible to aflatoxins. Aflatoxins B1, G1 and M1 can be found in sow's milk and intoxications caused by them have resulted

in damaged lymphocytes and macrophages in piglets.

The symptoms caused by mycotoxins depend upon their concentration in the feed, duration of exposure and the age and life stage of the afflicted animal.

We have so far talked about single mycotoxin effects in experimental conditions, but in the field multi-mycotoxin contaminations will also occur.

In experimental situations other routes of administration sometimes have to be resorted to as pigs can refuse to eat contaminated feed. Needless to say, in the field this would have a protective effect for the pigs. Mycotoxin problems usually only occur in a limited number of pigs and herd problems are unusual. However, the veterinarian would be prudent to have mycotoxins in his differential diagnosis options for reproductive problems in pigs.

Treatment tends to focus on the removal of the contaminated feed and there are no specific treatments. Prevention centres around Good Manufacturing Practices (GMP) in the feed mill and awareness by the farmer of the conditions which favour mycotoxin development on farm in feed bins (hygiene, temperature and moisture).

Monitoring programmes are to be recommended but can be cost restrictive. It should also be noted that mycotoxins can be masked from analytical detection by small molecules such as glycosides, glucuronides, fatty acid esters and proteins attached to the toxin resulting in false negative results.

Control strategies based on the use of toxin binders, acidifiers and toxin deactivators can be used.

Finally, there are some anomalies to keep in mind. These include:

- Mycotoxins may be present in feedstuffs despite negative analytical findings.
- Mycotoxins are usually not homogeneously distributed in the feed so can remain undetected.
- Clinical symptoms are often not very pronounced and/or vague. ■

Table 2. Clinical guide to mycotoxins affecting reproduction in pigs (Osweler, 9th edition of Diseases of Swine).

Mycotoxin	Category of pig	Dietary level	Clinical effects
Aflatoxins	Sows and gilts	>2,000ppb 500-750ppb	Acute hepatitis, in 3-10 days No effect on conception, normal piglets, slower growth due to aflatoxins in sow's milk
Trichothecenes	Nursery pigs Growers Sows	1ppm 3ppm 10ppm 20ppm	No effect Decreased feed consumption Decreased feed consumption, oral/dermal irritation and immunosuppression Complete feed refusal and vomiting
Zearalenone	Prepubertal gilts Cycling sows and gilts Pregnant sows	1-3ppm 3-10ppm >30ppm	Oestrogenic. Vulvovaginitis and prolapses Retained corpora lutea, anoestrus, pseudopregnancy Early embryonic death when fed 1-3 weeks post mating
Ergot	All pigs Sows in last third of pregnancy	0.1% 0.3% 3.0% 0.3%	Reduced weight gain Gangrene of ears, tail and hooves Decreased feed consumption Agalactia, reduced piglet weights, piglet starvation