International Journal of Advanced Research and Publications
ISSN: 2456-9992

Implications Of Feed-Borne Mycotoxins In Swine And Poultry Productions – A Review

Johnson, N. C., Iorliam, B

Rivers State University, Department of Animal Science
Nigeria, 234 909 462 4825
ntinya@alumni.uoguelph.ca

Federal University of Agriculture, Makurdi, Department of Food Science and Technology,
Nigeria, 234 813 902 9781
biorliam@gmail.com

Abstract: Mycotoxins are byproducts of fungi (fusaria) metabolism in crops in the field during production and in storage. There are many species of fusaria that produce mycotoxins. However, deoxynivalenol (DON) produced by Fusarium graminearum is most ubiquitous and mainly responsible for the observed toxicological impacts of mycotoxins in swine and poultry productions probably due to F. graminearum ability to produce more than one mycotoxin. Presence of DON in rations consumed by livestock, particularly swine and poultry negatively impact animal growth and performance with its attendant economic losses. Poultry have the ability to tolerate DON more than swine. This trend has resulted in diverting mycotoxins-contaminated grains for poultry feeding. However, this is still dangerous since diets formulated with mycotoxins also impact poultry production negatively, especially layers. Special precautions therefore should be taken before grain-containing mycotoxins are incorporated into poultry feeds, particularly during the so-called "fusarium years."

Key words: F. graminearum, DON, Production, Poultry and Swine

1 Introduction

Mycotoxins are metabolites of fungi that affect crops in the field during production and in storage. Presently, mycotoxins of fusaria fungi species are more ubiquitous and thus more prevalent in crops, globally. During the period of production in the field, fusaria produce these metabolites in the course of their normal metabolism. The toxic metabolites of fusaria are known as mycotoxins and the very cause of crop contamination, including cereal grains used in swine and poultry feeds. The presence of mycotoxins in grains usually results in substantial economic losses through reduced grain yield and damage to kernels thereby also reduced grain quality. These scenarios are well documented. Economic losses due to mycotoxins in cereal grains have been estimated to be over a billion dollars because of deoxynivalenol (DON) presence in grains due to decreased grain quality alone [1]. DON also known as vomitoxin is a mycotoxin produced by Fusarium graminearum. Furthermore, a computer simulated data suggest that annual costs of DON in grains losses based on wheat and corn estimates is $637 million, $18 million in feed losses and $2 million in livestock losses. Therefore, the implications of feed-borne mycotoxins could be very devastating to the livestock industry, including the poultry industry particularly from Fusaria mycotoxins. This is more so as Fusaria metabolites possess high toxicological effects in animals that consume rations in which they are present. This is even more problematic as F. graminearum can co-produce other toxic mycotoxins other than DON [2]. Table 1 shows fusaria species normally found in kernels of grains, their pathogenicity and mycotoxins they produce.

Table 1. Fusaria isolated from grain kernels, their pathogenicity and mycotoxins involved.

Species	Degree of toxicology	Mycotoxins
F. graminearum	High	DON, zearalenone (ZEN) and nivalenol
F. culmorum	Low	DON
F. crookwellense	Low	ZEN
F. avenaceum	Low	Moniliform
F. acuminatum	Low	Acumination
F. sporotrichiodes	Low	Diacetoxyscirpenol
F. poae	Very low	Diacetoxyscirpenol
F. equiseti	Very low	Diacetoxyscirpenol

Source: [2].

As shown in Table 1, F. graminearum is most responsible for mycotoxins found in grains, probably as co-producers of different mycotoxins leading to its high degree of toxicology [2]. Compared to swine, poultry has been shown to be more tolerant to mycotoxins, such as DON without severe impediments to performance. The general order of decreasing sensitivity has been acknowledged as pigs > mice > rats > poultry ~ ruminants [3], [4]-[5]. This may be partially explained due to differences on the effects of mycotoxins on the brain neurochemistry in these species, especially between swine and poultry [11]. This has resulted in the diversion of most mycotoxin-containing feed grains for poultry feeds. Different environmental factors such as temperature and moisture affect mycotoxin production. Higher mean values are unavoidable under favorable weather conditions. During favorable temperature and moisture availability, such as rainy season fasaria epidemics can occur. Years in which they occur are known as "Fusarium years." During "Fusarium years" care must be taken before suspected cereal batches are diverted to poultry feeding as mycotoxins are co-produced by Fusaria, especially F. graminearum which also produces mycotoxins that are toxic to poultry. This is very important in that except the levels of mycotoxins are ascertained because the consumption of eggs and meat from poultry that are fed diets containing mycotoxins, particularly DON can place consumers at risk and this is also of concern for human health [6]. Overall, the consumption of rations containing mycotoxins has grave consequences on performance, quality of animal products culminating in huge economic losses.

Effect of mycotoxins particularly DON on Feed intake (FI) and weight gain

Farm animals especially swine are very sensitive and susceptible to the effects of DON [7]. Pigs that are presented with DON-containing diets often exhibit reduced FI that may be exhibited by outright feed refusal. DON has been shown to be implicated in the suppression of the appetite system. In addition, DON is capable of stimulating the immune system of the animal [8]. To this point, DON consumption often alters the delicate balance of the immune system, particularly in young animals thereby affecting their normal feeding behavior. This culminates in anorexia and FI is reduced [9]. This condition consequently stimulates lipolysis with subsequent negative impacts on performance [8]. Some other studies had shown that DON causes emesis which further confirmed that DON affects the appetite system of the animal [10]. In these circumstances, DON predisposes or makes such animals vulnerable to infectious diseases thereby further aggravating decreased productivity as the animal uses the activated immune system in attempt to combat the condition [9]. These factors combined together are therefore responsible for the poor performance observed in using DON-containing grains [11]. Table 2 shows some of the effects of DON on FI in swine with the specific studies involved as summarized by [12].

Table 2. Some Major Adverse Effects of DON on Feed Intake

Effects	Literature source
Emesis and feed refusal	[10]
Decreased FI, growth and feed efficiency	[13]
Reduced FI and growth; stomach lesions	[14]
Depressed FI, growth, FE and carcass weight; reduced blood levels of total protein, albumin, Ca and P	[15]
Reduced FI and growth	[7]
Immediate reductions in FI and growth followed by partial dose-dependent recovery	[16]
Reduced FI and growth; increased corrugation of mucosa in stomach; transient decrease in serum protein levels	[17]
Renal lesions	[18]
Dose-dependent reduction in secondary antibody response to tetanus toxoid	[19]

Reference: [12]

Effects of DON on Nutrient Metabolism and Weight Gain

Closely related to the effects of DON on FI in animals, including swine and poultry is the issue of nutrient metabolism and weight gain in animal consuming DON in their rations. Since FI is positively correlated to weight gain, the reduction in FI if severe enough can lead to reduced body weight gains or body weight losses [20] thereby causing delays in the time taken by affected animals to reach market weights. This invariably results in losses on the part of the animal farmer [20]. DON has been shown to interfere with glucose, methionine and mineral metabolism [21]. Therefore, the reduction in the average daily gain of animals ingesting DON in their diets is not surprising. By impeding the metabolism of these important nutrients especially glucose the needed energy for maintenance and production purposes would be impaired. DON has also been shown to interfere with the activity of peptidyl transferase resulting in an inhibition in the process of protein synthesis [3]. These effects may also be at the root of the observed reductions in weight gain. As earlier stated any delay in reaching market weight associated with animals consuming DON in their diets would result in financial losses. The effect of reduced growth rate or weight gain is worse with the young and growing animals, such as gilts [4]. In the study of [4] gilts were found to be more susceptible to DON as seen in the delay in days to reach market weight compared with barrows that consumed the same level of DON in their diets. To this end, different studies have demonstrated that DON presence in the pig diets resulted in reduced growth rate with increasing DON concentrations in the diet. This effect is due mainly to reduced FI with concomitant reduction in average daily gain leading to increased feed: gain as a result maintenance energy becoming a greater proportion of intake. Consequently, some studies have shown that daily feed consumption, daily gain and feed efficiency was decreased by 25, 57 and 45%, respectively in pigs that were fed 4.8mg DON/kg of diet compared with a DON-free control for an experimental period that lasted for 5 days. Concentrations of dietary DON, number of times tested and effects of the ingested DON on animal performance had been summarized elsewhere [22].

2 Conclusion

DON is a mycotoxin produced by Fusarium graminearum. Presence of DON in rations consumed by livestock, particularly swine and poultry culminates in various negative impacts, including animal growth and performance parameters with its attendant economic losses. Poultry have the ability to tolerate DON more than swine. As a result of this trend, there is often a tendency in diverting mycotoxins-contaminated grains for poultry feeding. However, this is still very dangerous since diets formulated with mycotoxins also impact poultry production negatively, especially layers and young chicks. Therefore, special precautions should be taken before grain-containing mycotoxins are incorporated into poultry feeds, particularly during the so-called “fusarium years.”

3 References

[1]. R. M. Clear and S. K. Patrick. 2000. Fusarium head blight pathogens isolated from fusarium-damaged kernels of wheat in western Canada, 1993 to 1998. Can. J. Plant Pathol. 22: 52-60.

[2]. J. W. ApSimon. 1994. Mycotoxins in Grain. Compounds other than aflatoxin. Miller, J. D. and Trenholm, H. I. (Eds.) Eagan Press, St. Paul, MN, USA.

[3]. B. A. Rotter, D. B, Prelusky and J. J. Pestka. 1996. Toxicology of deoxynivalenol (vomitoxin). J. Toxicol. Environ. Health. 48:1-34.

[4]. J. D. House, D. Abrahamson, G. H., Crow and C. M. Nyachoti. 2002. Feed intake, growth and carcass parameters of swine consuming diets containing low levels of deoxynivalenol from naturally contaminated barley. Can. J. Anim. Sci. 82:559-565

[5]. J. D. House, C. M. Nyachoti, and D. Abrahamson, 2003. Deoxynivalenol removal

from barley intended as swine feed through the use of an abrasive pearling procedure. J. Agric. Food Chem. 51:51725175.

[6]. J. E. Smith, and G. Solomon. 1995. Role of mycotoxin in human and animal health. Natural Toxins. 3:182-192.

[7]. D. B. Prelusky, B. A. Rotter, and R. G. Rotter. 1994. Toxicology of mycotoxins. Pages 359-404 in J. D. Miller and H. L. Trenholm, Eds. Mycotoxins in grain. Compounds other than aflatoxins. Eagan Press, St. Paul, MN.

[8]. R. W. Johnson. 1998. Immune and endocrine regulation of food intake in sick animals. Domest. Anim. Endocrinol. 15:309-318.

[9]. R. W. Johnson. 1997. Inhibition of growth in the immunologically challenged pig. In: Proc. Eastern Nutrition Conference, Guelph, Ontario, pp. 28-33.

[10]. M. A. Diekman, and M. L. Green. 1992. Mycotoxins and reproduction in domestic livestock. J. Anim. Sci. 70:1615-1627.

[11]. H. V. Swamy, T. K. Smith, E. J. MacDonald, H. J. Boermans, and E. J. Squires. 2002. Effects of feeding a blend of grains naturally contaminated with Fusarium mycotoxins on swine performance, brain regional neurochemistry and serum chemistry and the efficacy of a polymeric glucomannan mycotoxin in adsorbent. J. Anim. Sci. 80:3257-3267.

[12]. J. P. F. D'Mello, C. M. Placinta, and A. M. C. Macdonald. 1999. Fusarium mycotoxins: A review of global implications for animal health, welfare and productivity. Anim. Feed Sci. Technol. 80:183-205.

[13]. B. Bergsjo, T. Matre, and I. Nafstad. 1992. Effects of diets with graded levels of deoxynivalenol on performance in growing pigs. J. Vet. Med. Series A 39:752-758.

[14]. , D. W. Friend, B. K. Thompson, H. L. Trenholm, H. J. Boermans, K. E. Hartin and P. L. Panich. 1992. Toxicity of T-2 toxin and its interaction with deoxynivalenol when fed to young pigs. Can. J. Anim. Sci. 72:703-711.

[15]. B. Bergsjo, W. Langseth, I. Nafstad, J. J. Hogset, and H. J. S. Larsen. 1993. The effects of naturally deoxynivalenol-contaminated oats on the clinical condition, blood parameters, performance and carcass composition of growing pigs. Vet. Res. Comm. 17:283-294.

[16]. H. L. Trenholm, , B. C. Foster, L. L. Charmley, B. K. Thompson, K. E. Hartin, R. W. Coppock, and M. A. Albassam. 1994. Effects of feeding diets containing Fusarium (naturally) contaminated wheat or pure DON in growing pigs. Can. J. Anim. Sci. 74:361-369.

[17]. B. A. Rotter, B. K. Thompson, and M. Lessard. 1995. Effects of DON-contaminated diet on performance and blood parameters in growing swine. Can. J. Anim. Sci. 75:297-302.

[18]. R. B. Harvey, T. S. Edrington, L. F. Kubena, M. Elissalde, H. H.Casper, G. E. Rottinghaus, and J. R. Turk. 1996. Effects of dietary fumonisn B1-containing culture material, DON-contaminated wheat, or their combinations on growing barrows. Am. J. Vet. Res. 57:1790-1794.

[19]. G. Overnes, T. Matre, T. Sivertsen, H. J. S. Larsen, W. Landseth, L. J. Reitan, and J. H. Jansen. 1997. Effects of diets with graded levels of naturally DON-contaminated oats on immune response in growing pigs. J. Vet. Med. Series A 44:539-550.

[20]. S. Danicke, H. Valenta, F. Klobasa, S. Doll, M. Ganter, and G. Flachowsky. 2004. Effects of graded levels of fusarium toxin contaminated wheat in diets for fattening pigs on growth performance, nutrient digestibility, deoxynivalenol balance and clinical serum characteristics. Arch. Anim. Nutr. 58:1-17.

[21]. G. Hunder, K. Schumann, G. Strugala, J. Gropp, B. Fichtl, and W. Forth. 1991. Influence of subchronic exposure to low dietary deoxynivalenol, a trichothecene mycotoxin, on intestinal absorption of nutrients in mice. Food Chem. Toxicol. 29:809-814.

[22]. Y. Dersjant-Li, M. W. A. Verstegen, and W. J. J. Gerrits. 2003. The impact of low concentrations of aflatoxin, deoxynivalenol or fumonisin in diets on growing pigs and poultry. Nutr. Res. Rev. 16:223-239.