



# The Poultry Informed Professional®



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## Threat of Mycotoxins to Poultry in North America

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Mycotoxin contamination of poultry feeds appears to be on the increase globally. This is especially true for North America owing to the high level of *Fusarium* mold contamination of the 2009 corn crop and subsequent mycotoxin production. This paper highlights the current mycotoxin scenario in North America with special emphasis on *Fusarium* mycotoxins and their impact on poultry performance

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Broiler Live Production Cost	Average Company
Feed Cost/ton w/o color (\$)	245.94
Feed cost /lb meat (c)	22.64
Days to 4.6 lbs	41
Chick cost / lb (c)	5.01
Vac-Med cost/lb (c)	0.05
WB & ½ parts condemn. Cost/lb	0.16
% mortality	4.13
Sq.Ft. @ placement	0.83
Lbs/sq. ft.	7.10
Downtime (days)	17

Data for week ending 30th January 2010

## **Current Situation in North America**

The biggest concern for the North American poultry producers in the year 2010 will be the contamination of corn with molds and mycotoxins. There are a several factors leading to this situation. Firstly, much of the 2009 corn was stored with higher-than-usual moisture levels because a particularly wet fall hindered dry-off (Wulf, 2010). Secondly, the 2009 corn harvest was later than it has been in living memory (Fatka, 2009). Thirdly, although January 2010's freezing weather halted the corn quality decline, the snowy weather has also kept some farmers from getting their corn to storage / marketed. Fourthly, February and March 2010 have been predicted to be warmer than expected and this will increase the potential for corn damage and mycotoxin production during storage.

Heavy early season snow has been an added hindrance and reports indicate that 1.2 billion bushel of corn has been caught in snow-banks. North Dakota was worst affected with only 54% of corn harvested, while Illinois, South Dakota, Minnesota and Nebraska each had more than 1 million acres yet to harvest by the middle of Dec 2009. It is difficult to know what the field losses in these areas will be, especially since some of this corn may not be harvested until the spring. According to a University of Wisconsin study, corn harvested in April will yield 24% less than if it had been harvested in October 2009. Losses will be even higher if the crop is combined in the winter, with losses estimated to reach as high as 65% if harvested in March.

In spite of having high moisture corn, many producers tried to hold onto their stocks in the hopes that prices would improve. It wasn't long however before they were forced to sell because the damaged corn in storage began to spoil as temperatures rose, and quality declined. There are predictions that this forced selling may create a temporary oversupply and cause prices to tumble as much as a dollar per bushel (Wulf, 2010).

An Iowa processors was quoted as saying that one-quarter of farmers currently selling corn are delivering high-moisture corn that is prone to deterioration and difficult to store. According to a recent report, up to 75% of on-farm stored grain is suffering from at least some quality issue. The situation is likely to get worse as the weather warms (Wulf, 2010). The last time the US had storage issues with corn was in 1992, which caused corn deliveries to increase 5% during the second quarter of the marketing year. This would equate to roughly 500 million bushels of corn this year.

## **Mycotoxins**

Mycotoxins are metabolites produced by fungi (moulds) that can infest crops pre-harvest and can continue to flourish under sub-optimal storage conditions. Grains with high moisture content are particularly unstable and prone to mould proliferation and possible mycotoxin production. Excess rainfall at harvest and at key periods during the growing season can be a major promoter of mycotoxin contamination of feedstuffs.

### ***Aspergillus* mainly in tropics**

The most significant species of mycotoxin-producing fungi that have an impact on poultry production would include *Aspergillus* and *Fusarium*. The most significant mycotoxin produced by *Aspergillus* fungi are the aflatoxins. The fungi that synthesize aflatoxins, *A. flavus* and *A. parasiticus*, are considered to be tropical or semi-tropical moulds that thrive under conditions of high moisture and temperature. The effects of feed-borne aflatoxin on poultry production have been extensively studied and we have a good understanding of the tolerance of various classes of poultry. This is partly due to concern for human health and food safety issues arising from contamination of poultry products with aflatoxin, since aflatoxin is a potent hepatocarcinogen.

Another important mycotoxin is the nephrotoxin ochratoxin A. This compound is produced by *Aspergillus ochraceus* and *Penicillium verrucosum*. As with aflatoxin, there is concern that residual ochratoxin A in poultry products could pose a threat to human health due to the possible carcinogenic nature of this compound.

### ***Fusarium* in temperate climates**

*Fusarium* fungi flourish in more temperate climates. Our understanding of *Fusarium* mycotoxicoses in poultry is much less complete than our understanding of aflatoxicosis. This is in part because of the very large number of *Fusarium* mycotoxins, more than one hundred that have been chemically characterized, which makes complete analysis of feedstuffs for *Fusarium* mycotoxins impractical, if not impossible. The most commonly recognized *Fusarium* mycotoxins include the trichothecenes, a large family of structurally-related compounds including deoxynivalenol (DON, vomitoxin), T-2 toxin, nivalenol, diacetoxyscirpenol (DAS) and over 100 others, zearalenone, an oestrogenic compound, fumonisins and fusaric acid.

### **Analysis of mycotoxins in poultry feeds**

A major source of error in mycotoxin analysis is inadequate sampling of feedstuffs, with sampling accounting for approximately 82% of the variability in analysis. Proper sampling protocols have been developed and published in an effort to minimize this source of error. However, even with such protocols, error is unavoidable as mycotoxins are not evenly distributed within a batch but occur in hotspots. Even with correct sampling, as an example, from a 25 ton batch of feed, approximately 100 sub-samples should be taken comprising a total of 25kg, from this a 250g sub-sample is taken and eventually a 1g sample analysed. Considering that only 1g is analysed from 25 tonnes, it is hardly surprising that mycotoxin analysis isn't accurate! Another source of error is the potential presence of different chemical forms of mycotoxins which may escape routine analysis. Attention has been focused on the presence of conjugated forms of mycotoxins that are produced by plants.

### **Masked mycotoxins**

The synthesis of conjugated/masked mycotoxins may be the result of detoxification of mycotoxins by plant metabolism and it has been suggested that the presence of conjugated mycotoxins might be used in making genetic selection of plant resistance to fungal invasion (Liu et al., 2005). Although conjugated forms of deoxynivalenol (DON, vomitoxin) were identified many years ago (Sewald et al., 1992), little information is available about the relative significance of conjugated and free mycotoxins in poultry diets. Schneeweis et al. (2002) identified glucose conjugated zearalenone in samples of wheat. Naturally-contaminated wheat and corn samples from Slovakia have been found to contain glucose-conjugated DON with up to 29% of deoxynivalenol in a glucose conjugated form (Berthiller et al., 2005). More recently, Zhou et al. (2007) reported an increase in DON concentrations of up to 88% when barley samples from North Dakota were treated with trifluoroacetic acid prior to analysis. Such acid treatment would hydrolyse all different conjugates of DON. Similar acid treatment of different barley samples showed up to 21% of total DON found in conjugated forms (Zhou et al., 2008). Most recently, Zachariasova et al. (2008) have found even higher levels of bound DON in barley and beer using a variety of analytical techniques.

The frequency of bound fumonisin routinely exceeded free fumonisin in samples of European corn and corn-based foods (Dall'Asta et al., 2008). It is not yet clear if the conjugated forms of mycotoxins are as harmful to poultry as the parent compounds, but it has been shown that some conjugated mycotoxins can be hydrolyzed in the digestive tracts of animals (Gareis et al., 1990).

### **The current mycotoxin analytical values are underestimated**

It must be concluded that until we have a better understanding of the frequency, toxicity and nature of conjugated mycotoxins, current mycotoxin analysis of poultry feeds should often be considered to be an underestimate of correct values. To further complicate matters, there exists a number of different analytical techniques (for example ELISA and HPLC) which vary in accuracy and can be sensitive to interference from some dietary components (such as in DDGs). It should also be noted that typically feeds are only analysed for the pres-

ence of certain 'indicator' mycotoxins. It is well established that mycotoxins rarely occur in isolation and that mycotoxins when present in combination can act synergistically to produce more pronounced detrimental effects in the bird. It is necessary at this time, therefore, to consider mycotoxin analysis of feeds as offering only an approximation of the true hazard posed by the feeding of contaminated materials to poultry

### **Effects of *Fusarium* mycotoxins on poultry performance**

A series of studies has been conducted to determine the effects of feeding blends of naturally-contaminated feedstuffs, largely corn and wheat, to different types of poultry. This was done in an effort to mimic conditions seen in commercial poultry production where diets contain multiple vectors of mycotoxin contamination. The mycotoxins in such diets were determined to be mainly DON with lesser amounts of zearalenone and 15-acetyl DON in addition to fusaric acid. Three different modes of action of the mycotoxins fed were identified: (1) reductions in cellular protein synthesis (2) reduced immunity (3) alterations in brain neurochemistry.

Reductions in cellular protein synthesis result in lesions of the gastrointestinal tract including necrosis, gizzard erosion, haemorrhaging, and malabsorption of nutrients. Reduced hepatic protein synthesis can decrease utilisation of dietary amino acids resulting in increased uric acid synthesis as amino acids are oxidised for energy purposes.

Many *Fusarium* mycotoxins, as well as aflatoxin and ochratoxin, have been shown to be immunosuppressive. This results in increased susceptibility to disease, lingering health problems in the flock and possible failure of vaccination programmes. The disease symptoms arising from immunosuppression, moreover, are not symptoms characteristic of mycotoxins. They are only indirectly caused by mycotoxins and this makes certain identification of mycotoxins as the causative agent of reduced flock health very difficult.

Combinations of feed-borne *Fusarium* mycotoxins are pharmacologically active. This means they have drug-like properties due to their effects on brain neurochemistry. The most reproducible effects observed are elevations in brain regional concentrations of serotonin. Such changes alter behaviour including reductions in feed intake, loss of muscle coordination and increased lethargy.

### **Broilers**

The feeding of a blend of ingredients naturally-contaminated with a combination of *Fusarium* mycotoxins resulted in reduced growth in the grower phase, elevations in blood uric acid levels, discoloration of breast meat and immunosuppression (Swamy et al., 2002, Swamy et al., 2004a). Changes in brain neurochemistry were also seen (Swamy et al., 2004b).

### **Broiler Breeders**

The feeding of a similar combination of *Fusarium* mycotoxin contaminated materials to broiler breeders significantly reduced hatchability due to reduced shell thickness of fertile eggs (Yegani et al., 2006a). Changes in brain neurochemistry were also observed (Yegani et al., 2006b). There were no effects of diet on sperm quality. In a parallel study with broiler breeder pullets, immunosuppression (Girgis et al., 2008) and delayed coccidiosis recovery (Girgis et al., 2010) was noted when birds were fed *Fusarium* mycotoxins.

### **Laying Hens**

Laying hens were very sensitive to the feeding of combinations of *Fusarium* mycotoxins. Egg production and

feed efficiency were reduced while major increases in blood uric acid concentrations were seen (Chowdhury and Smith, 2004a). The elevations in blood uric acid levels were likely due to a reduction in hepatic fractional protein synthesis rates (Chowdhury and Smith, 2005a). Immunosuppression was also observed (Chowdhury and Smith, 2005b).

### Turkeys

Turkeys were very sensitive to the feeding of high levels of *Fusarium* mycotoxin-contaminated feeds. Growth rates were significantly reduced even in the starter phase (Table 1; Chowdhury and Smith, 2007) and some indices of immunosuppression were seen (Chowdhury et al., 2005a). The feeding of lower concentrations of *Fusarium* mycotoxins (2.2 ppm DON) also reduced growth rates, elevated blood uric acid levels and caused immunosuppression (Girish et al., 2008a). This was coupled with morphological changes in the small intestine (Girish and Smith, 2008) and changes in brain neurochemistry (Girish et al., 2008b). These findings are further supported by the recent research at North Carolina State University wherein significant performance losses were noted when turkeys were fed 1.7 ppm DON from naturally-contaminated grains for 21 days (Grimes et al., 2010).

**Table 1: Impact of *Fusarium* mycotoxins on growth performance of turkeys**

Phase	Control	Contaminated
Starter	632 <sup>a</sup>	573 <sup>b</sup>
Grower	1845 <sup>a</sup>	1676 <sup>b</sup>
Developer	2446 <sup>a</sup>	2220 <sup>b</sup>

### Ducks

Ducks were quite resistant to the feeding of combinations of grains naturally- contaminated with *Fusarium* mycotoxins (Chowdhury et al., 2005b). Indices of immunosuppression, however, were observed.

### **Minimize contamination**

It can be concluded that poultry are sensitive to combinations of feed-borne *Fusarium* mycotoxins and that the feeding of contaminated materials should be minimized. It appears that the frequency of mycotoxin contamination of poultry feeds is increasing. This may be due in part to adverse weather conditions pre-harvest in many parts of the world arising from global climate change. The complex nature of modern poultry rations including the increasing use of potentially contaminated by-products such as distillers' dried grains adds to the possibility of toxicological synergy between combinations of mycotoxins, thereby increasing the severity of the response of poultry to contaminated feeds.

Many of the adverse effects seen in the studies reviewed above could be prevented by the simultaneous feeding of a polymeric glucomannan mycotoxin adsorbent (Alltech Inc.). The use of an appropriate mycotoxin adsorbent is likely the best short-term strategy available for minimizing the adverse effects of feedborne mycotoxins in poultry feeds. It is hoped that long-term strategies such as improved quality control measures arising from advances in analytical methodology and plant breeding strategies to reduce the susceptibility of plants to fungal invasion will help to minimize mycotoxin challenges to the poultry industries in the future.

**References are available upon request**

# Excerpts from the latest USDA National Agricultural Statistics Service (NASS) “Broiler Hatchery,” “Chicken and Eggs” and “Turkey Hatchery” Report and Economic Research Service (ERS) “Livestock, Dairy and Poultry Situation Outlook”

## Chickens and Eggs

Released January 22, 2010, NASS Agricultural Statistics Board, U.S.D.A.

### December Egg Production Up 1 Percent

U.S. egg production totaled 7.83 billion during December 2009, up 1 percent from last year. Production included 6.76 billion table eggs, and 1.07 billion hatching eggs, of which 995 million were broiler-type and 72 million were egg-type. The total number of layers during December 2009 averaged 340 million, down slightly from last year. December egg production per 100 layers was 2,304 eggs, up 1 percent from December 2009.

All layers in the U.S. on January 1, 2010 totaled 340 million, down slightly from last year. The 340 million layers consisted of 284 million layers producing table or market type eggs, 53.8 million layers producing broiler-type hatching eggs, and 2.94 million layers producing egg-type hatching eggs. Rate of lay per day on January 1, 2010, averaged 73.8 eggs per 100 layers, up 1 percent from January 1, 2009.

### Egg-Type Chicks Hatched Up 7 Percent

Egg-type chicks hatched during December 2009 totaled 39.7 million, up 7 percent from December 2008. Eggs in incubators totaled 38.9 million on January 1, 2010, up 6 percent from a year ago.

Domestic placements of egg-type pullet chicks for future hatchery supply flocks by leading breeders totaled 309 thousand during December 2009, up 55 percent from December 2008.

### Broiler-Type Chicks Hatched Down Slightly

Broiler-type chicks hatched during December 2009 totaled 778 million, down slightly from December 2008. Eggs in incubators totaled 633 million on January 1, 2010, up slightly from a year earlier. Leading breeders placed 6.66 million broiler-type pullet chicks for future domestic hatchery supply flocks during December 2009, up 1 percent from December 2008.

## Broiler Hatchery

Released February 3, 2010, by the National Agricultural Statistics Service USDA

### Broiler-Type Eggs Set In 19 Selected States Up 2 Percent

Commercial hatcheries in the 19-State weekly program set 202 million eggs in incubators during the week ending January 30, 2010. This was up 2 percent from the eggs set the corresponding week a year earlier. Average hatchability for

chicks hatched during the week was 83 percent. Average hatchability is calculated by dividing chicks hatched during the week by eggs set three weeks earlier.

### Broiler Chicks Placed Down 1 Percent

Broiler growers in the 19-State weekly program placed 165 million chicks for meat production during the week ending January 30, 2010. Placements were down 1 percent from the comparable week a year earlier. Cumulative placements from January 3, 2010 through January 30, 2010 were 666 million,

## Turkey Hatchery

Released January 15, 2010, by the National Agricultural Statistics Service USDA

### Eggs in Incubators on January 1 Down 7 Percent from Last Year

Turkey eggs in incubators on January 1, 2010, in the United States totalled 27.5 million, down 7 percent from January 1, 2009. Eggs in incubators were up 4 percent from the December 1, 2009 total of 26.6 million eggs.

Regional changes from the previous year were: East North Central down 8 percent, West North Central down 2 percent, North and South Atlantic down 10 percent, and South Central and West down 18 percent.

### Poults Hatched During December Down 7 Percent from Last Year

Turkey poults hatched during December 2009, in the United States totalled 22.6 million, down 7 percent from December 2008. Poults hatched were up 5 percent from the November 2009 total of 21.5 million poults. Regional changes from the previous year were: East North Central down 1 percent, West North Central up slightly, North and South Atlantic down 14 percent, and South Central and West down 19 percent.

### Net Poults Placed During December Down 5 Percent from Last Year

The 22.1 million net poults placed during December 2009 in the United States were down 5 percent from the number placed during the same month a year earlier. Net placements were up 5 percent from the November 2009 total of 21.1 million.

## Current Month Charts

Broiler Performance Data Live Production Cost	Region					Average Company
	SW	Midwest	Southeast	Mid-Atlantic	S-Central	
Feed Cost/ton w/o color (\$)	246.46	229.70	249.88	246.17	246.21	246.22
Feed cost /lb meat (c)	22.69	21.25	22.83	23.23	23.00	22.67
Days to 4.6 lbs	42	41	41	40	40	41
Chick cost / lb (c)	4.75	4.82	4.98	4.39	4.86	4.90
Vac-Med cost/lb (c)	0.04	0.06	0.08	0.04	0.02	0.05
WB & ½ parts condemn. Cost/lb	0.17	0.16	0.16	0.19	0.16	0.18
% mortality	3.95	4.50	4.75	4.09	3.79	4.07
Sq.Ft. @ placement	0.78	0.80	0.82	0.91	0.81	0.82
Lbs/sq. ft.	7.24	7.18	6.99	7.21	7.58	7.13
Downtime (days)	15	14	18	20	19	17
Broiler Whole Bird Condemnation	Region					Average Company
	SW	Midwest	Southeast	Mid-Atlantic	S-Central	
% Septox	0.159	0.174	0.125	0.175	0.097	0.147
% Airsac	0.040	0.063	0.080	0.063	0.038	0.058
% I.P.	0.009	0.010	0.006	0.024	0.031	0.025
% Leukosis	0.000	0.001	0.000	0.001	0.001	0.001
% Bruises	0.002	0.001	0.005	0.003	0.002	0.003
% Other	0.007	0.008	0.013	0.011	0.008	0.008
% Total	0.218	0.258	0.229	0.275	0.176	0.242
% ½ parts condemnns	0.249	0.220	0.222	0.268	0.307	0.270

Data for week ending January 23rd 2010

## Previous Month Charts

Broiler Performance Data Live Production Cost	Region					Average Company
	SW	Midwest	Southeast	Mid-Atlantic	S-Central	
Feed Cost/ton w/o color (\$)	242.73	225.27	247.58	242.14	243.13	242.65
Feed cost /lb meat (c)	22.14	20.40	22.34	22.76	22.40	22.17
Days to 4.6 lbs	41	40	40	40	40	40
Chick cost / lb (c)	4.64	4.80	5.06	4.38	4.84	4.86
Vac-Med cost/lb (c)	0.03	0.06	0.07	0.04	0.02	0.04
WB & ½ parts condemn. Cost/lb	0.15	0.16	0.18	0.18	0.14	0.17
% mortality	3.48	3.96	3.85	3.60	3.27	3.65
Sq.Ft. @ placement	0.78	0.79	0.82	0.92	0.81	0.82
Lbs/sq. ft.	7.31	7.09	6.82	7.19	7.51	7.12
Downtime (days)	17	14	20	22	20	40

Broiler Whole Bird	Region					Average Company
	SW	Midwest	Southeast	Mid-Atlantic	S-Central	
% Septox	0.140	0.189	0.152	0.147	0.073	0.141
% Airsac	0.032	0.046	0.089	0.050	0.035	0.051
% I.P.	0.008	0.010	0.005	0.023	0.023	0.019
% Leukosis	0.000	0.001	0.001	0.002	0.001	0.001
% Bruises	0.002	0.001	0.006	0.002	0.002	0.003
% Other	0.006	0.009	0.012	0.009	0.005	0.007
% Total	0.189	0.256	0.265	0.234	0.138	0.222
% ½ parts condemnns	0.228	0.264	0.225	0.282	0.294	0.269

Data for week ending December 26th 2009

# Meetings, Seminars and Conventions

**2010**

**March**

**March 14-16: 61<sup>st</sup> North Central Avian Disease Conference** Call for Titles. St. Paul River Centre, St. Paul, Minnesota. Titles and a brief description should be submitted by December 1, 2009 to Dr. Daniel Shaw (573-884-0879) at [shawd@missouri.edu](mailto:shawd@missouri.edu) (Veterinary Medical Diagnostic Laboratory, P.O. Box 6023, Columbia, MO 65205)

**2010**

**April**

**April 18-21, 2010: The 59th Western Poultry Disease Conference (WPDC) and American College of Poultry Veterinarians Workshop** will be held at The Fairmont Hotel Vancouver - Vancouver, BC, Canada. Information regarding title submission, registration and hotel can be found on the WPDC website: <http://conferences.ucdavis.edu/wpdc>.

**April 20-23: VIV Europe 2010**, Utrecht, The Netherlands. Contact: XNU Exhibitions Europe B.V, P.O. Box 8800, 3503 RV Utrecht, The Netherlands, Fax: +31 302-952-809; Website: [www.viv.net](http://www.viv.net)

**April 26-30: XII Internatinal Seminar on Avian Pathology and Production.** Program in Spanish and English. AMEVEA-University of Georgia, Athens, Georgia. , 2010. Contact: Dr. Pedro Villegas, Univ. of Georgia. [Seminar2010@uga.edu](mailto:Seminar2010@uga.edu)

**2010**

**June**

**May 31st-June 1st GVMA** Sandestin Florida. Contact Dr Glisson PDRC, University of Georgia.

**2010**

**August**

**August 1-4, 2010 AVMA/AAAP 2010 Scientific Program** at the Georgia World Congress Center in Atlanta, Georgia, USA. AAAP is calling for submissions of papers to the Poultry Section for Oral & Poster Presentations. Applications must be submitted on or before December 1, 2009. Submissions can be done online on our web site at: [2010 AVMA/AAAP Meeting - Call for Papers Online Submission Form](#) or by completing the application form (pdf) and submitting to: [2010AAAP@aaap.info](mailto:2010AAAP@aaap.info)

**August 23-27, 2010 - XIIIth European Poultry Conference** in Tours, France.

**2010**

**September**

**September 2-7, 2010. Options for the Control of Influenza VII.** Hong Kong, SAR, CHINA. Launched in 1985 this international conference is devoted exclusively to influenza for all disciplines involved in influenza prevention, control and treatment, including seasonal and pandemic planning.

**2010**

**October**

**October 4-6, 2010. 45<sup>th</sup> National Meeting on Poultry Health and Processing.** Clarion Resort Fontainebleau Hotel Ocean City, Maryland

**2011**

**September**

**September 19-24, 2011. XVII Congress & Exhibition of the World Veterinary Poultry Association** Cancun, Mexico. More info: [www.congressmexico.com](http://www.congressmexico.com)



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## Reminder

All previous issues of the Poultry informed Professional are archived on our website [www.avian.uga.edu](http://www.avian.uga.edu) under the Online Documents and The Poultry Informed Professional links.