# THE ROLE OF MYCOTOXINS IN PMWS – FACT OR FICTION

D.G.S. BURCH Octagon Services Ltd,
Old Windsor, Berks, SL4 2NR

C. ROWSELL Syngenta UK Ltd,
Whittlesford, Cambridge, CB2 4QT

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**Summary**

*It has been postulated that mycotoxins may play a role in the development of porcine circovirus type 2 (PMWS), as the main infectious agent associated with the disease, was found well before the disease syndrome started, while the development of the syndrome coincided with a number of wet harvests in the UK. There was an increase in the incidence of fusarium ear blight at this time. However, a representative survey (320 samples) of grain production in the UK taken in early 2000 showed that the incidence of deoxynivalenol was high (88%), although all samples were below the acceptable target level for grains of 750ppb. The detectable incidence of ochratoxin A was lower at 16%; but 3.4% of samples were over the acceptable limit of 5ppb. The pattern of detection across the country did not correlate with the disproportionate reported incidence of the disease of 88% of cases in East Anglia and zero in Scotland, where the incidence of ochratoxin A was the highest. It is considered that other factors, possibly husbandry practices in East Anglia, may be of more significance in the development of the disease syndrome*

## Introduction

The cause of post-weaning multisystemic wasting syndrome (PMWS) in its severe form appears to be multifactorial (Madec *et al*, 2000) although porcine circovirus type 2 (PCV-2) appears to be the underlying cause of the disease and will produce a mild form of the condition in gnotobiotic pigs (Ellis *et al*, 2000). Porcine parvovirus (PPV) has been associated with the severe form of the disease (Kennedy *et al*, 2000), as has porcine reproductive respiratory syndrome virus (PRRSV), a more renowned immuno-suppressive virus. Pogranichnyy *et al*, (2001) showed statistically that the odds of having PMWS was increased markedly when both PCV-2 and PRRSV were present in a herd.

There is still speculation about the factors involved in the syndrome where growing pigs show progressive wasting, pallor, sometimes jaundice, pneumonia, enteritis and death. Lymph nodes are enlarged; but there is

depletion of lymphoid cells and replacement with macrophages in the nodes and Peyers patches in the intestine. Due to the multitude of clinical signs, a number of possible causes have been proposed.

In the UK, the problem has been most severe in East Anglia (Gresham and Thomson, 2001), especially in the large three site production system farms, where a rapid increase in incidence was observed since 1999. Wet weather has been a problem and it has been postulated that wet harvests and possible mycotoxin contamination of the grain may also be a contributing factor (Done, 2001). It also coincided with the introduction, in 1998, of a new family of fungicides for crop protection called the strobilurins.

It is the purpose of this paper to look at the possible role of mycotoxins as a factor in this condition.

## Major fungal infections and mycotoxin production in UK grain

There are two major categories of fungal infection and contamination, those that occur during growth and development of the ear especially at the time of flowering in June and those that occur at storage mainly in humid conditions.

**Table 1 - Major fungal infections of grain**

| Situation | Fungal species | Main mycotoxins |
|---|---|---|
| Infection in field | Fusarium | Tricothecenes* A & B (wheat, barley, oats)<br>Zearalenone (wheat, barley, oats, maize)<br>Fumonisins (maize) |
| | Claviceps | Ergot (wheat, barley) |
| Infection at storage | Aspergillus | Aflatoxins (peanuts, maize, cotton seed)<br>Ochratoxins* (wheat, barley, oats) |
| | Penicillium | Ochratoxins (maize) |

*Major mycotoxins in UK grain.
(European Commission report, November 1999)

The major causes of fusarium ear blight in small grains are *F. culmorum* and *F. graminearum.* Usually the infection is highest in wet weather, especially during flowering in June. Damage by insects may also increase infection but contamination from previous crops; poor tillage and strain susceptibility are also important contributory factors. Storage of grains in warm, humid conditions, especially if inadequately dried, tends to increase the growth of fungus and the potential of mycotoxin contamination. Both *A. ochraceus* and *P. viridicatum* are the most common contaminants of grain and both produce

ochratoxin A; although *P. viridicatum* is more commonly associated with maize.

**Effects of mycotoxins in pigs**

Mycotoxins are reported to have a wide range of effects on pigs, often depending on the contamination level in the feed. Some of the effects are similar to those described in PMWS, namely immunosupression, liver damage and jaundice, pulmonary oedema and poor growth rate.

**Table 2 - Effect and level of mycotoxin in pigs**

| Mycotoxin | Dietary Level | Clinical effect |
|---|---|---|
| Tricothecenes Type B*<br>Deoxynivalenol (DON, vomitoxin) | 1-2ppm<br>2-4ppm<br><br>5-10ppm | Reduced feed intake<br>Reduced growth rate and increased liver weight. No effect on lymphoid tissue.<br>25-50% reduced feed intake. |
| Tricothecenes Type A<br>T-2 toxins | 1ppm<br>3ppm<br>10ppm | No effect<br>Reduced feed intake<br>+ Immunosupression, dermal irritation |
| Fumonisins | 20-50ppm<br>50-100ppm<br>>120ppm | Liver changes<br>+ Reduced growth, jaundice<br>+Acute pulmonary oedema |
| Zearalenone | 1-3ppm | Oestrogenic effects |
| Ochratoxin* | 200ppb<br>1ppm<br>4ppm | Mild renal lesions, reduced weight gain<br>+Polydipsia<br>+Polyuria |
| Aflatoxins | 2-400ppb<br>4-800ppb<br>8-1200ppb<br>12-2000ppb | Reduced growth and feed intake<br>+ Liver lesions, immunosupression<br>+ Jaundice, rough coat<br>+ Some deaths |

* Major mycotoxins in UK grain
(Osweiler, 1999; European Commission report, December 1999)

**Control of fusarium ear blight**

The use of fungicides have been a common approach to control fungal infections of the developing ear; although there have been mixed results reported and the correct timing of application has been difficult. Other factors appear to be more important with regard to incidence and level of infection, such as rainfall.

Triazoles (tebuconazole, *etc*.) were routinely used and in 1998 a new family of fungicides, the strobilurins were introduced: - azoxystrobin (Amistar – Syngenta), kresoxym-methyl (Landmark- BASF) and, more latterly, trifloxystrobin (Twist-Bayer). These products are mainly active against fungi found on foliage and not on Fusarium, the cause of ear blight. In dry weather, such as in the mid-nineties, this would not be a problem; but their increased use coincided with wetter growing conditions, so a combination approach of triazoles + strobilurins has been introduced to try to control the problem.

**Table 3 - Incidence of fusarium ear blight in the UK 1995-2000**

| Year | Crops Affected (%)* | Ears Affected (%)* | Rainfall June (mm)** |
|---|---|---|---|
| 1995 | 1 | 0.2 | 12.1 |
| 1996 | 1 | 0.1 | 22.8 |
| 1997 | 22 | 1.8 | 124.7 |
| 1998 | 62 | 12.1 | 110.2 |
| 1999 | 32 | 3.0 | 71.4 |
| 2000 | 36 | 4.8 | 17.2 |

* Central Science Laboratory, York
** Rainfall in June in Cambridge (30 year average was 48.6mm)

In the UK, a series of surveys have been carried out to discover the incidence of PMWS and the other PCV-2 associated condition, porcine dermatitis and nephropathy syndrome (PDNS), during late 1999 and 2000. A disproportionate number of cases of PMWS (88%) and PMWS (91%) occurred in East Anglia, compared to the rest of the country and Scotland and the number of pigs produced in those regions.

**Table 4 - Survey results on the incidence of PMWS and PDNS**

| Survey | 8/1999 – 12/1999 | | 12/1999 – 4/2000 | | 4/2000 – 12/2000 | |
|---|---|---|---|---|---|---|
| Country/Region | PMWS | PDNS | PMWS | PDNS | PMWS | PDNS |
| England, Wales | 21 | 105 | 170 | 146 | 132 | 226 |
| Scotland | 0 | 2 | - | - | 0 | 1 |
| East Anglia | Mainly | Mainly | 158 | 139 | 109 | 200 |
| South West | Few | Few | 8 | 5 | 10 | 9 |
| Yorks/Humberside | - | - | 0 | 1 | 12 | 9 |

Survey 1a & b. Gresham *et al*, 2000a; Thomson *et al*, 2000.
Survey 2. Gresham *et al*, 2000b.
Survey 3. Gresham and Thomson, 2001.

A survey of the incidence of mycotoxins was carried out by the Central Science Laboratory, York for the Home Grown Cereals Authority between January and April 2000, on the 1999 harvest. Samples (320) were collected on

a representative basis of production of cereal, region and use i.e wheat, barley and oats for feed, flour and malting purposes in England, Scotland and Northern Ireland. Each sample of grain was analysed for the two most common mycotoxins found in UK grain, namely deoxynivalenol to represent contamination by fusarium ear blight and Ochratoxin A as indicative of possible poor storage. The acceptable limits for deoxynivalenol are currently 750ppb for grain and grain products and 5ppb for ochratoxin A.

**Table 5 - Survey results for mycotoxins and for Ochratoxin by region**

| Mycotoxin/ Region | No of samples | Not detected (%) | Below limit (%) | Above limit (%) |
|---|---|---|---|---|
| Deoxynivalenol | 320 | 11.6 | 88.4 | 0 |
| Ochratoxin A | 320 | 83.8 | 12.8 | 3.4 |
| Eastern | 60 | 86.7 | 10.0 | 3.3 |
| South West | 31 | 87.1 | 12.9 | 0 |
| Yorks/Humber. | 46 | 87.0 | 10.9 | 2.2 |
| Scotland | 45 | 73.3 | 17.8 | 8.9 |

CSL, 2000

Deoxynivalenol was detected widely; but none were above acceptable limits of 750ppb and only 1 was above 500ppb. Ochratoxin A, by comparison, was rarely detected but was found in levels above acceptable limits of 5ppb, the highest being found in Scotland where the incidence of PMWS is zero.

## Conclusions

1. PCV-2 appears to be the fundamental agent for the cause of PMWS.

2. When mixed with other viruses, especially PRRSV, a higher risk of severe disease can be expected. Other infections may be identified in the future, such as *Pasteurella multocida* in PDNS (Thomson *et al*, 2001).

3. The regional incidence of the disease in the UK, with the predominance in East Anglia, is also worthy of further examination. The extensive three-site system of production and other husbandry factors may have a major effect on the original development of the disease by creating the right environment for the various infectious factors to cause the severe form of the disease.

4. The role of mycotoxin contamination of UK grain as a component of this multifactorial disease is considered highly unlikely. The widespread occurrence of low levels of deoxynivalenol in grain samples does not correlate well with the regional incidence of the disease. The low incidence of detection of ochratoxin A, with occasional above acceptable limits, does not correlate at all with the incidence of the

disease, as Scotland, with the highest incidence of contamination, has not recorded a case of PMWS to date.

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