IMPORTANCE OF ZEARALENONE IN COMMERCIAL POULTRY

Manuel Contreras, DVM, MS, Dipl. ACPV
Agrimprove/Special Nutrients

Miami, FL, USA.

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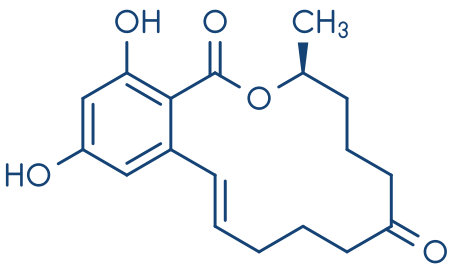
Zearalenone (ZEN) **is one of the top three mycotoxins contaminating finished feed and grains.** Many worldwide reports, from different institutions, indicate that more than half of the samples evaluated show some level of contamination with this toxin.

ZEN has been used as a marker for decades, indicative of the presence of other mycotoxins produced by the genus Fusarium, such as Vomitoxin (DON) and Fumonisin.

- **Fungi belonging to the genus Fusarium are very abundant** and regularly **contaminate growing plants and grains during storage.**
- **Plants alter the chemical structure of mycotoxins as part of their defense mechanism against xenobiotic substances** (foreign to the ecological system where they grow).
- ***Fusarium graminareum* and *F. culmorum*, besides producing ZEN, also generate DON,** which emphasizes the importance of synergism among mycotoxins, once ingested by animals.
- **ZEN is heat-stable during storage, grinding, processing, and distribution,** and can stand temperatures of 150°C for about 44 hours.



ZEN and its metabolites

ZEN and its metabolites are very potent estrogens, of the non-steroidal type. So far, it is the only mycotoxin identified that causes primary estrogenic effects in animal production, especially in sows and dairy cows.

For more than 50 years, a metabolite of ZEN, called zearalanol, marketed as **Zeranol**, has been sold in several countries. This is an **anabolic agent capable of accelerating body weight** gain in weaned calves, steers and animals raised in confinement (feed lots).

Susceptibility

Pigs are considered the most sensitive domestic species, followed by ruminants. **Commercial birds are the most resistant**. Within this latter group:

- **Broilers are the hardiest,**
- **Turkeys the most susceptible.**
- **Leghorn (white) layers have proven to be very resistant,** in scientific tests conducted with high levels of contamination with ZEN.

Mechanism of absorption and formation of metabolites

Once ZEN is ingested, a portion is excreted through urine and feces without absorption through the blood, representing a rapid elimination mechanism.

Another portion of ZEN is rapidly absorbed through the epithelial cells of the small intestine, thereby passing into the bloodstream to subsequently be metabolized in the liver into other metabolites that can be excreted within the:

- intestines,
- via bile and
- then returned to the liver via enterohepatic circulation.

Mycotoxins with enterohepatic recirculation are secreted through the bile into the intestinal lumen, increasing their exposure time and once again exerting their toxicity on the epithelial tissue.

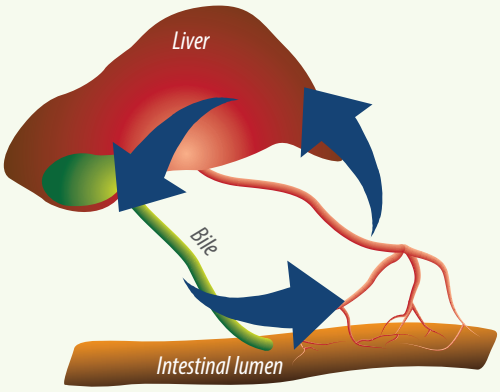


Figure 1. *Enterohepatic recirculation system.*

In the liver, its transformation occurs because of the enzyme 3 α/β-hydroxysteroid dehydrogenase (3 HSE) convert it into two isomers:

- Alpha zearalenol (α ZAL) and
- Beta zearalenol (β ZAL).

This enzyme causes the hydroxylation of ZEN, a process that detoxifies it. As far as estrogenic effects, α ZAL is 500 times more potent than ZEN, while β ZAL is 16 times less potent.

In other words, the production of α ZAL increases the toxicity of ZEN while the production of β ZAL convert it into a less toxic metabolite.

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We must emphasize that there are other metabolites of ZEN, besides alpha and beta ZAL.

Metabolically, pigs can transform ZEN mostly into β ZAL while chickens can convert it to alpha ZAL, to a greater extent.

In several scientific studies in pigs treated with ZEN, derivatives of α ZAL are more prevalent in biological fluids such as blood plasma, urine, and bile.

Why are birds less susceptible to ZEN than pigs?

Below, we mention **three probable causes that seem to explain this phenomenon:**

1 Low bioavailability of ZEN metabolites in birds/ Activity of the enzyme 3-HSE

The bioavailability, which is the proportion of the mycotoxin or metabolites that can be absorbed and cause damage to the animal, is 80-85% in the case of porcine. On the other hand, in poultry and rats, **it is less than 10%. The lower the availability of these metabolites in body fluids, the lower the harmful effects caused to the body.**

2 Elevated levels of ZEN excretion in feces and bile

The excretion capacity of ZEN and its metabolites in the feces and bile of chickens appears to be more efficient than in pigs. This means that they will be eliminated more quickly and as a result, a lower level of exposure to the toxic will occur.

3 Lower sensitivity of birds to estrogens in blood.

Commercial birds have been shown to be highly tolerant to ZEN, possibly because of naturally showing higher concentrations of estrogens in blood.

Natural estrogens, circulating in the blood streams, have a greater affinity with blood receptors than with ZEN and its metabolites.

Under natural conditions, **the blood estrogen levels in commercial poultry is 1.3 to 3.0 times higher than in pigs.**

This factor could help birds adapt to and resist ZEA interference with estrogen in the presence of low concentrations.

What are the macroscopic (gross) lesions associated with ZEN?

In some technical-commercial publications, **the following lesions are described: Cyst formation in the oviduct, prolapse of the rectum, broken eggs due to shell weakness, and reduction of the testicles weight in breeding males.**

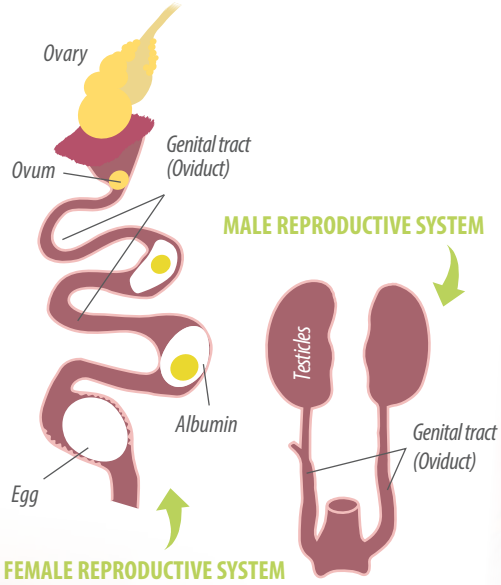

Figure 2. *Reproductive system of birds*

A scientific publication from 1986 *(Avian Pathology, Bock and collaborators)*, among others, already reports the presence of some of these lesions in breeding hens and males. According to the paper, **the commercial ration evaluated had 5 ppm of ZEN.**

It is important to point out that under commercial conditions, it is very rare to detect such a high level of contamination with ZEN.

In the case of breeding hens and commercial layers, most of the lesions already described are frequently reported in many flocks.

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Cysts formation:

Cysts on the ovary can be the result of early infection with the infectious bronchitis (IB) virus in pullets. For decades, some IBV strains have shown a mark tendency to affect reproductive organs (tropism).

In **2011, a new viral strain of IBV** was identified in the **Delmarva Peninsula, US, called DMV/1639.** This virus **has spread to various regions of North America and the world, and causes ovarian cysts.**

To **establish a reliable differential diagnosis, ELISA titers** should be **evaluated as well as PCR, and/or viral isolation.**

Of course, ZEN concentrations in feed should always be measured to rule it out.

- **Prolapse of the rectum, this injury is frequent in commercial layers and the list of factors that can cause it is very extensive, including the lightning program** (light intensity)**, nutritional deficiencies, management practices, etc.**
- **Shell weakness, regularly appears after a certain age in commercial hens and can be caused by viral agents and nutritional deficiencies.**
- **Atrophy of the testicles. Most of the time, it is the result of low feed consumption. If roosters get sick, less feed will be ingested, and testicles will become lighter.**

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As far as management, If males are feed restricted in excess, the testicles will show atrophy. This is a quite common condition where feed consumption is strictly controlled to avoid low fertility (broiler breeders).

CONCLUSION

In conclusion, **the identification of ZEN in feed or its metabolites in blood or other corporal fluids, does not necessarily indicate that the lesions observed in the reproductive tract or other organs are caused by this mycotoxin.**

Even though we consider that the effect of ZEN on the reproductive tract is exaggerated, the damage that it could cause on the immune system, combined with others such as Aflatoxin, Vomitoxin, T2 toxin, Fumonisin, and others, should not be underestimated.