# MYCOTOXINS

## What are and Which types exist

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### What are mycotoxins?

Mycotoxins are secondary metabolites produced by fungi in the plants before or after harvest. A large percentage of the agricultiural production worldwide is contaminated by at least one mycotoxin.

- Due to the economic and health impacts, the interest in fungi and mycotoxins they produce is enormous.

Mycotoxins are known worldwide as hazardous metabolites of fungal origin. Mycotoxins can contaminate all kinds of raw materials and cause significant damage to animals health and production. Therefore, mycotoxins are included within the group of undesirable substances in animal feed regulated by the EU Directive 2002/32 EC, transcribed into the Spanish legislation by the Royal Decree 465/2003

| FUNGUS | TOXINS PRODUCE |
|---|---|
| *Aspergillus* | Aflatoxins |
| | Sterigmatocystin |
| | Ochratoxin A |
| *Fusarium* | Trichothecenes (DON, NIV, Toxin T2, DAS) |
| | Zearalenones |
| | Fumonisins |
| | Fusarin |
| | Monilifomin |
| *Penicilium* | Patulin |
| | Citrinine |
| | Ochratoxin A |
| *Alternaria* | Alternariol |
| | Tenuazonic acid |
| *Claviceps* | Alkaloids |

# TYPES OF MYCOTOXINS

Classification according to
**WHERE they are GENERATED**

## "PRE-HARVEST" MYCOTOXINS

- Invade grains before or after the harvest (always before the threshing machine).
- Includes different species requiring high levels of moisture in the grain (20-22%).
- Produced by the genera *Fusarium* (trichothecenes, zearalenone, fumonisins), *Claviceps* and *Neotyphodium* (ergot alkaloids).

## "POST-HARVEST" MYCOTOXINS

Produced by genera such as *Aspergillus*, which is primarly responsible for the production of aflatoxins, and by *Penicillium*, *Monascus* or *Mucor* on forages and silages

# TYPES OF MYCOTOXINS

## "PRE-HARVEST" MYCOTOXINS

### FUSARIUM MYCOTOXINS

*Fusarium* is a genus of mould that is a part of the field flora (phytopathogenic substrates, living plants) and intermediate flora (substrates of freshly picked and still wet cereals).

This mould vegetates at a temperature between 6 and 40°C, with an optimum between 18 and 30°C. It is aerobic and, in general, it needs water activity ($a_w$) higher than 0.88 to grow and proliferate and higher than 0.91 to produce mycotoxins. Zearalenone is produced at temperatures between 10-14°C.

*Fusarium* mycotoxins affecting the livestock are:

- **Zearalenone** (ZEN)
- **Fumonisin B1** (FB1)
- **Trichothecenes** (vomitoxin or deoxynivalenol (DON), T-2 toxin, and diacetoxyscirpenol (DAS).

#### ZEARALENONE (F-2)

Zearalenone (ZEN) is essentially produced by:

- *Fusarium roseum*
- *F.tricinctum*
- *F.roseum* "Culmorum"
- *F.roseum*"Equiseti"
- *F.roseum* "Gibbosum"
- *F.roseum* "Graminearum"
- *F.oxysporum*
- *F.moniliforme*

*Fusarium roseum* produces the highest concentrations of zearalenone (3000-15000 mg/Kg), while *Fusarium moniliforme* produces smaller amounts of zearalenone raging from 1-19 mg/Kg.

There are **16 different derivatives of zearalenone** of which the most important and toxic is **zearalenone**, followed by **zearalenol**.

As a natural contaminant, zearalenone can be found in corn and its by-products, barley, wheat, oats, sorghum, sesame seed, rapeseed, hay and silage.

#### FUMONISINS

Fumonisins are essentially produced by *Fusarium moniliforme*. There are 6 types of fumonisins: B1, B2, B3, B4, A1 and A2. However, the most frequent and the most important ones are **fumonisin B1** (FB1) and **fumonisin B2** (FB2), which can be found as a natural contaminant in cereals (preferably in corn and corn by-products).

#### TRICHOTHECENES

Essentially produced by:

- *Fusarium tricinctum*
- *F.nivale*
- *F.roseum*
- *F.graminearum*
- *F.solani*
- *F.oxysporum*
- *F.lateritium*
- *F.sporotrichioides*
- *F.rigidiusculum*
- *F.episphaeria*
- *F.poae.*

Other moulds, can also produce trichothecene toxins, such as:

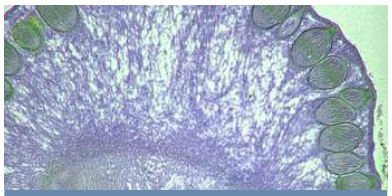
- *Cephalosporium crotocigenum*
- *Myrotecium verrucaria*
- *Stachybotrys atra*
- *Calonectria nivalis*
- *Trichoderma viride*
- *Tricotecium roseum*
- *Gibberella saubinetti*

There **are more than 40 derivatives of trichothecenes**. However, the most frequent natural contaminants are as follows:

- Toxin T-2
- Diacetoxiscirpenol (DAS)
- Vomitoxin or deoxynivalenol (DON)
- Nivalenol.

Trichothecenes are named after the tetracyclic skeleton 12,13-epoxytrotec-9-ene, contained in their molecule.

As natural contaminants, trichothecene toxins can be found in cereals (corn and corn by-products, barley, sorghum, oats, wheat and wheat by-products, rice, rye and millet).



### CLAVICEPS MYCOTOXINS

Ergot (*Claviceps purpurea*) is a parasitic fungus of the *Claviceps genus* that **contains more than fifty species.**

All of them can affect a wide variety of cereals and herbs, although **rye** is their most common host.

The most parasitized cereal is rye, hence its name "ergot rye", although it can also parasitize wheat, oats, barley, grass, ray grass, millet.

Infestations of this fungus cause the **reduction in quality and quantity of grains and hay**, and if these infected crops are used to feed livestock, they have negative effects on their production as well. **The most affected species is bovine.**

# "POST-HARVEST" MYCOTOXINS

## ASPERGILLUS MYCOTOXINS

### AFLATOXINS

Essentially produced by *Aspergillus flavus* and *Aspergillus parasiticus*. There are so far 18 types of aflatoxins of which the most toxic are aflatoxin B1 (AFB1) and aflatoxin M1 (AFM1) (the letter is a metabolic derivative of aflatoxin B1).

These are followed, in order from higher to lower toxicity, by aflatoxins G1 (AFG1), M2 (AFM2), B2 (AFB2) and G2 (AFG2) (aflatoxin M2 is a metabolic derivative of aflatoxin B2).

As natural contaminants, Aflatoxins can be found in cereals (essentially, in corn, wheat, sorghum and rice) and cereal products, oil-seed turtles (cotton, peanut, rapeseed, coconut, palm kernel and sunflower), oil plants (cotton, peanut, rapeseed, coconut, palm kernel oil and sunflower), cassava and in a variety of food intended for human consumption, such as cereal products, nuts, sausage products, spices, wine, legumes, fruits, milk and dairy products.

## PENICILLIUM MYCOTOXINS

### OCHRATOXINS

Ochratoxins are produced by Aspergillus ochraceus, *Penicillium viridicatum* and *Penicillium cyclopium*. There are in total 7 types of ochratoxins, out of which the most toxic is ochratoxin A (OTA).

As a natural contaminant, ochratoxin A can be found in cereals (essentially, in barley and rice), cereal products, peanut flour and in a variety of food intended for human consumption, such as raw coffee beans, legumes, cheese, smoked meats (ham, bacon and sausages).