Mycotoxins

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Symptoms of mycotoxicosis

- Symptoms are diverse
- Some elicit few symptoms until death
- Severe effects include (a) skin necrosis and

  b) immunosuppression

Mycotoxins

- Mycotoxins - toxins produced by micro-fungi
  eg *Aspergillus* spp. (Macro-fungi, eg. mushrooms)

- Mycotoxins have 4 basic toxicity - acute, chronic, mutagenic, teratogenic.

Mycotoxins

- Toxigenic moulds - *Aspergillus, Penicillium, Fusarium* are found on human food and animal feed - animal products, eg meat or milk may become contaminated.
- Other toxigenic moulds may be present in the environment.

Fungal toxins

- Unlike bacterial toxins, fungal toxins (mycotoxins) are not proteins and therefore are not usually detectable by the immune systems of humans and animals

Mycotoxigenic filamentous fungi

- *Rhizopus* spp.
- *Byssochlamys* spp.
- *Claviceps* spp.
- *Eupenicillium* spp.
- *Eurotium* spp.
- *Neosartorya* spp.
- *Talaromyces* spp.
- *Alternaria* spp.
- *Aspergillus* spp.
- *Penicillium* spp.
- *Fusarium* spp.
- *Cladosporium* spp.
- *Geotrichum candidum*
- *Paecilomyces variotii*
- *Phomopsis* spp.
- *Stachybotrys* spp.
- *Trichoderma viride*
- *Wallemia sebi*

Types of mycotoxins

- There are over 300 mycotoxins but the commonly occurring ones in food and feed.

- About 20 mycotoxins occur in food at levels and frequency to be of food safety concern.

Mycotoxins associated with food and feed

- Aflatoxins **(B1, B2, G1, G2, M1)**
- Ochratoxin A
- Zearalenone
- Fumonisins
- Trichothecenes
- Patulin
- Moniliform
- Sterigmatocystin
- Citrinin
- Cyclopiazonic acid
- Kojic acid
- Maltoryzine
- ß-nitropropionic acid
- Aspergillic acid
- Penicillic acid
- Roquefortine C

Mycotoxins and world food supply

- It is estimated that 25% of world's food crops are affected annually by variable levels of mycotoxins.
- >100 countries have regulations regarding levels of mycotoxins in food and feed.

Principal toxigenic moulds and food crops

- ***Aspergillus ochraceus*** - cereals, nuts, pulses, oilseeds, corn….. ochratoxins, penicillic acid
- ***A. flavus*** *or* ***A. parasiticus*** - cereals, nuts, root crops, oilseeds, pulses…….aflatoxins
- ***Penicillium*** spp. - cereals, root crops, nuts, beans……..ochratoxin, patulin, citrinin
- ***Fusarium*** spp. - cereals, root crops ….. T-2 toxins, zearalenone

Toxicological effects of AFLATOXINS

- the most toxic mycotoxin (in particular AFB1)
- they are genotoxic carcinogens
- they cause cancer and have been linked to liver cancer in a number of developing countries
- not possible to determine threshold below which this toxin has no effect
- therefore No Tolerable Daily Intake has been recommended.

Aflatoxin M1

- Aflatoxin M1 is an oxidative metabolite of Aflatoxin B1.(ie produced from AFB1 in mammals)
- Aflatoxin M1 may be present in milk and dairy products.
- Aflatoxin M1 has been reported in human breast milk particularly in developing countries - Middle East, Africa, South Asia.

Toxicological effects of OCHRATOXIN A

- damages and causes cancer of the kidneys (shown in laboratory animals);
- has been associated with development of Balkan Endemic Nephropathy - a specific type of kidney disease in certain human population;
- EU have set a TDI of <5 ng/kg per kg body wt per day (kg/bw/d)

Toxicological effects of PATULIN

- exhibits strong antibiotic activity against bacteria;
- causes haemorrhage, oedema and dilation of the intestinal tract of experimental animals
- EU have endorsed a provisional maximum TDI of 0.4 µg/kg bw/d

Toxicological effects of FUSARIAL TOXINS

- ***Fumonisins*** cause kidney and liver damage; oesophageal cancer; TDI of 2µg/kg bw/d
- ***Trichothecenes*** (DON, T-2, HT-2 toxins) causes growth retardation, reproductive and intestinal effects, also affects immune systems; a group TDI of 1 µg/kg.
- ***Zearalenone*** has oestrogenic effects. A possible incidence of precocious puberty associated with zearalenone in Hungary; EU TDI of 0.2 µg/kg bw/d.

Human mycotoxicosis

In 1967, 26 Taiwanese in a farming community became ill after eating contaminated rice; 3 children died.

Cause of death: Contaminated rice showed >200 µg aflatoxin B1/kg.

Human mycotoxicosis

In 1974, an outbreak of hepatitis in India affected 400 people resulting in 100 deaths;

Cause of death: aflatoxins in corn (>15 **mg**/kg)

Human mycotoxicosis

In 2004, one of the largest aflatoxicosis outbreak occurred in rural Kenya resulting in 317 cases and 125 deaths.

Cause of death: corn contaminated with 4,400 µg/kg of aflatoxin B_1, 220 times higher than Kenyan regulatory limit for food.

Mycotoxins and EU Regulation 1881/2006

Mycotoxin	Fruits, etc	Cereals, etc	Milk, etc	Coffee, wine	Nuts, spices	Baby food
Aflatoxins $B_1B_2G_1G_2$	√	√			√	√
Aflatoxin M_1			√			√
Trichothecenes (DON, T2 toxins)		√				√
Zearalenone		√				√
OTA	√	√		√	√	√
Patulin	√					√

Aflatoxicosis

- Aflatoxicosis is caused by aflatoxins produced by the fungi, e.g. *Aspergillus flavus*.
- Four types of aflatoxins have been described i.e. aflatoxin B_1, B_2, G_1 and G_2.
- Animals consuming feeds contaminated with aflatoxin B_1 leads to secretion in the milk of aflatoxin M_1 and M_2

Effects of aflatoxins

- When consumed in large doses, they are lethal in causing acute hemorrhagic syndromes
- Sub-lethal doses cause histotoxic changes
- Long term consumption of small doses cause liver tumors as these are potent carcinogens.

Prevention of aflatoxicosis

- Proper drying and storage of grains and other affected foods
- Quality control of potentially hazardous foods to ensure that they do not contain above the allowable limits of 20 ppb before consumption by use of appropriate analytical tests.
- Use of fungicides as seed dressings to protect stored cereals and other foods like pulses and potatoes against fungal invasion.