

FUNGI AND MYCOTOXINS

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Introduction:

- “Myco” means mold and “toxin” represents poison
- Mainly low molecular weight proteins
- Under proper environmental conditions (temperature, moisture, oxygen ...), mycotoxin levels become high

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Mycotoxins

Some mycotoxins:

- Lethal effects
- Cause specific diseases
- Effect on the immune system
- Act as allergens or irritants
- No known effect on human and animal health
- Act on other micro-organisms, such as penicillin's antibiotic action
- Effective in animal feed or food, and sometimes both,
- Human and animal health has been proven.

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History:

- Ergotism and mushroom poisoning
- Alimentary toxic aleukia (ATA), with more than 5000 deaths caused by trichothecene mycotoxins in grain in the USSR late in World War II
- In 1960, in which 100,000 turkeys died of an unknown disease

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Mycotoxin production and occurrence

Can occur:

- **In the field;** *Aspergillus flavus* and some *Fusarium* species
- **Pre-harvest;** some *Fusarium* species and *Trichothecium*
- **Processing ?**
- **Transportation ?**
- **Storage;** *Penicillium* are mainly found

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Aflatoxin

- Can be produced by three species of *Aspergillus*—*A. flavus*, *A. parasiticus*, and the rare *A. nomius*
- Aflatoxin B₁ is a potent liver carcinogen and DNA-damaging agent
- Aflatoxins are very heat resistant and are difficult to remove from foods and feeds
- Aflatoxins M₁ and M₂ are the hydroxylated metabolites of aflatoxins B₁ and B₂ and can be found in milk or milk products

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Ochratoxins

- Produced by *Aspergillus* and *Penicillium*
- Occurs primarily in cereal grains and mixed feeds, but it can also be found in beans, coffee, fruit juices, nuts, olives, cheese, fish, pork, milk powder, pepper, wine and beer

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Fumonisin

- Produced primarily by *Fusarium verticillioides*
- Most common fungi colonizing corn and corn-based foods as well as other grains (such as sorghum and rice) throughout the world
- Several reports of a possible role in the etiology of human esophageal cancer

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Trichothecenes

- Toxic metabolites produced in the genus *Fusarium*
- Affect many organs, such as the gastrointestinal tract and the hematopoietic, nervous, immune, hepatobiliary and cardiovascular systems
- Alimentary toxic aleukia (ATA).
- T-2 toxin is a highly toxic type A TCTC

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Deoxynivalenol

- Produced primarily by *F. graminearum*
- Feed refusal and emesis in swine, named "vomitoxin"
- It is considerably less toxic than most other mycotoxins

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Sterigmatocystin

- Produced by fungi in the *Aspergillus*, *Bipolaris*, and *Chaetomium* genera and by *Penicillium luteum*
- Precursor in the metabolic pathway to aflatoxin production, but is toxic in its own right, though not as potent as aflatoxin B1

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Genus *Penicillium*

- Cyclochlorotine, luteoskyrin, and rugulosin are hepatotoxic mycotoxins
- **patulin**, penicillic acid, citrinin, cyclopiazonic acid, citreoviridin and xanthomegnin
- Patulin is often found in damaged apples, apple juice, apple cider
- At least 10 countries have regulatory limits

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Mycotoxin preventive measures

Toxin formation :

- Using resistant varieties
- Good agricultural practice
- Drying grain to less than 10–13%
- Antifungal agents and phenolic antioxidants and antibiotics

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Mycotoxin preventive measures

Monitoring programs to avoid human exposure:

- Monitoring and measures of mycotoxins in food and animal feed
- TLC, HPLC and GC techniques
- New chemical methods
- Capillary electrophoresis
- Fluorescence polarization
- Immunoassay (simple approach)
- Biosensors

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Mycotoxin preventive measures

Remove mycotoxins from commodities

- Chemical detoxifiers, including acids, alkalis, aldehydes
- Oxidizing agents and gases such as chlorine, sulfur dioxide, NaNO₂, ozone, ammonia are used for aflatoxins, fumonisin and trichothecene.

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Mycotoxin preventive measures

Cooking and pasteurization

- Do not destroy mycotoxins generally
- Extrusion cooking is effective for detoxifying DON, and roasting has some effect in reducing OA in coffee

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Miscellaneous fungi -Ergot

- Convulsive type, convulsions, tingling sensation of muscles, and sometimes the entire body is racked by spasms
- European and most other countries, limit of 0.1–0.2%
- In the US, wheat or rye with 0.3% sclerotia is considered unsafe and oats, triticale, or barley having more than 0.1%
- Ethiopian epidemic in 1978 from ergot-infested oats. Approximately 50% of the affected persons died
- Similar problems occurred in India in the 1970's

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Mushrooms

- *Amanita phalloides* (Death Cap)
- *Amanita muscaria*
- *Coprinus atramentarius*
- *Galerina* spp.
- *Gyromitra esculenta*
- *Psilocybe mexicana*
- Quorn™ ?!

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Amanita phalloides **(Death Cap)**

- Contains 2–3 mg of amatoxins per gram of dry tissue
- A single mushroom can kill an adult human
- Vomiting, nausea, abdominal pain, and bloody diarrhea that develops within 6–24 hours
- These signs may lessen for a short period of 12–24 hours followed by confusion, delirium, seizures, and coma
- The mortality rate in humans is 10–40%

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Amanita muscaria

- Death does not usually occur when these are the only toxins in the poisonous mushrooms
- Fly agaric also contains amatoxins and phallotoxins
- Fatal combination of symptoms may occur.

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Coprinus atramentarius

- Symptoms typically begin about 30 minutes after drinking alcohol
- May occur for as long as 5 days after mushroom ingestion

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***Galerina* spp.**

- Small, brownish mushrooms commonly growing on wood
- These mushroom are easily confused with the edible, two-toned *Pholiota* (*Kuehneromyces mutabilis*) that also grows on wood in clumps

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Gyromitra esculenta

- Contains gyromitrin
- Causes a bloated feeling, nausea, vomiting, watery or bloody diarrhea, abdominal pain, muscle cramps, faintness, and loss of motor coordination
- Typically occur 6–12 hours after eating the mushrooms
- Illness can progress to convulsions, coma, and death

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Psilocybe mexicana

- Mexican mushrooms, magic mushrooms, or shrooms
- Symptoms begin about 30–60 minutes after ingestion
- include pleasant or apprehensive mood, unmotivated laughter and hilarity, compulsive movements, muscle weakness, drowsiness, hallucinations, and finally sleep
- Death in small children

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Quorn™

- Mycoprotein is derived from *Fusarium venenatum*
- Quorn™ foods have been available in Europe for over 17 years
- Quorn™ foods have been eaten by 20 million consumers, in nearly one billion servings

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Quorn™

- Center for Science in the Public Interest (CSPI): hundreds of people are becoming violently ill with problems such as vomiting and diarrhea from eating Quorn
- The company has acknowledged that some people do not tolerate the product well (one in 146,000)
- The FDA says it has contacted many of the people who have reported falling ill from Quorn™ products, no evidence of it being a serious threat

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Summary

- Many fungi that grow on plants in the field and on feedstuffs and foodstuffs after harvest produce toxins that threaten animal and human health.
- Mycotoxins in animal feeds may eventually threaten humans via foods of animal origin.
- Once present in feeds or foods, mycotoxins are very difficult to eliminate.

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Summary

- Several species of mushrooms also contain toxins that can cause serious illness and death if eaten.
- A new meat substitute made of fungal protein has attracted the attention of a consumer-advocate organization, which wants it banned.

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