Mycotoxins
Prevention and Reduction in Cereals and Oilseeds

Ife Adekoya
Aurora Canada
AFs intoxication even at a dose of 1 µg/kg/bw/day could contribute to cancer development, immune suppression and growth inhibition (JECFA, 2001)

Every time you eat or drink you are either feeding a disease or fighting it

Heather Morgan
Nutritionist, counsellor and lifestyle coach
Cereals

- Fruits of cultivated grasses of the monocotyledenous family *Graminae*.
- Examples are; wheat, sorghum, oats, barley, rye, rice, maize and millets
- Successful production, storage and utilization has contributed to the development of modern civilization
- Utilized for human food production, animal feed, industrial use and as seeds
Utilization

- Food; rolled oat, bread, cake, pasta, breakfast cereals
- Industrial use; malting, brewing, distillation, starch, adhesive and alcohol production
- Seed; 6.6% of the barley produced worldwide in 2004 was used as seed (FAOSTAT, 2005).
- Animal feed
Oil Seeds

- Grains that are valuable for the oil content they produce.
- Seeds from which oil is expressed e.g. sunflower seed, rapeseed, canola, safflower, flaxseed, mustard seed.
- Expressed oils are used as salad or cooking oils, solidified to make margarine and shortening.
- Also used in manufacture of printing inks, erasers, coating or core oils, greases, plastics, etc.
Production Statistics

Figure 1  World grain production by region (2015/16)

- Europe: 29%
- CIS: 16%
- N & C America: 14%
- NE Asia: 10%
- Far E Asia: 3%
- N Africa*: 3%
- S Hemisphere: 25%

*N Africa plus Ethiopia and Nigeria

Source: International Grains Council
Challenges facing Cereals and Oilseed Production

- Inadequate knowledge on the use of herbicides and pesticide, postharvest handling, processing and marketing and soil fertility management
- Dependency on rudimentary, labour, and time consuming hand tools for farm operations.
- Lack of industrial drive due to poor government policy
- Climate change
- Pest and diseases e.g. fungi infestation
Fungi Infestation

- Results in reduction of grain quality
- Changes colour, taste & smell
- Reduction in nutritional value
- Increases free fatty acids
- Reduces germination ability
- Fungal diseases may be highly hazardous as certain species of fungus produce mycotoxins
Why Mycotoxins

- A series of toxic secondary metabolites, produced by various mould species
- Presence of mould does not necessarily mean mycotoxins are present.
- Even if there is no evidence of fungi – mycotoxins might still be present.
- There are more than 400 mycotoxins characterized.
- They show acute as well as chronic toxicity to both animals and humans.
- More than 25% of the world’s crops are contaminated with mycotoxins.
Types of Mycotoxins
Aflatoxin

• A. ochraceus, Aspergillus flavus and A. parasiticus. aflatoxin-producing species
• Natural contamination of cereals & oilseeds and a long list of other commodities is a common occurrence.
• Aflatoxin is associated with both toxicity and carcinogenicity in human and animal populations.
• The four major aflatoxins are $B_1$, $B_2$, $G_1$, and $G_2$
• FB1 is the most prevalent *Fusarium* toxin produced
  • Hepatotoxic
  • Nephrotoxic
  • Suspected to be carcinogenic in humans
• Found mostly in maize-based human food and animal feeds
Ochratoxin

- Produced by; *P. Verrucosum* and *A. ochraceus*
- Food affected; Cereals, coffee beans, and grapes.
- Ochratoxin A is potentially **carcinogenic** to humans *(Group 2B)*, and has been shown to be weakly **mutagenic**, possibly by induction of oxidative DNA damage
Mycotoxin Chain of Events

Fig 4: Mycotoxin chain of events
Source http://www.foodtech-international.com/papers/images/mycotoxins/figure1.gif
Examples of mycotoxigenic fungi that affects cereals and oil seeds before and after production

• Fungi species that are frequently found on the field; *A. flavus, A. alternata, Claviceps purpura, Fusarium verticillioides, F. graminearum* e.t.c.

• Species most likely introduced at harvest include; *Cladosporium sp., A. alternata* e.t.c.

• Species associated with storage; *Penicillium citrinum, P. islandicum, P. verruculosum, P. expansum*
Examples of Occurrence of Mycotoxins in Cereals and Oil Seeds in Nigeria

- Worldwide, several studies have shown high levels of mycotoxins in some cereals available and oil seeds including Nigeria
  - Fumonisin in Maize (Chilaka..., 2016, Onyedum..., 2020)
  - Aflatoxin B1 in Melon (Bankole.., 2006, Obani...,2019)
  - Aflatoxin B1 in Groundnut (Oyedele...,2017)
  - 54 toxic secondary funagal metabolities were detected in groundnut from the 4 agro-ecological zones of Nigeria including aflatoxins (B1, B2, G1, G2, M1), ochratoxin, beauvericin, nivalenol, moniliformin. Aflatoxin was present in 39% of the same with maximum levels at 2076 ug/kg
# Some Reported African Mycotoxin Outbreak

<table>
<thead>
<tr>
<th>Mycotoxin</th>
<th>Outbreak detail</th>
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<td>Ergot Alkaloids</td>
<td>An outbreak occurred in Ethiopia in 1978, 97 people developed gangrenous ergotism through the consumption of contaminated bread (King, 1979).</td>
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Management of mycotoxins in cereals and oil seeds.

• The economic implications of the mycotoxin problem and its potential health threat to humans have clearly created the need to eliminate or at least minimize mycotoxin contamination of food and feed.

• Studies have revealed that seeds are contaminated with mycotoxins prior to harvest. Therefore, their management must include both pre- and postharvest control measures.
Pre-harvest Control

- Good Agricultural Practices
- Crop rotation
- Insect management and pest control
- Early harvesting; Rachaputi et al. (2002) reported that early harvesting and threshing of groundnuts resulted in lower aflatoxin levels and higher gross returns of 27% than in delayed harvesting
• Genetic engineering is also useful in the development of host resistance through the addition or enhancement of antifungal genes.

• Bio Control: Use of atoxigenic biocompetitive, native A. flavus strains to out-compete the toxigenic isolates has been effective. Dorner and Cole (2002) reported a field application of non-toxigenic strains of A. flavus and A. parasiticus that reduced post-harvest aflatoxin contamination by 95.9%.
Postharvest Control

- Proper storage
- Proper drying: rapid drying of agricultural products to low moisture level is critical
- Physical treatment: This is based on separation of contaminated grain from the bulk and depends on the heavy contamination of only a small fraction of the seeds, so that removing those leaves a much lower overall contamination.
• Awareness creation; This is a long-term intervention strategy which has been advocated. Awareness of what mycotoxins are and the dangers that they pose to human and animal health is being done through government bodies, private organizations, non-governmental organizations, national media networks such as radios and television programs as well as features in newspapers and magazines.

• Case study: Adekoya et al, 2017
These strategies are not the end of the road

There are challenges of:

- Climate change and changing fungal species
- Modified (masked) mycotoxins
- How to deal with contaminated food and feed batches?
- Co-occurrence of multiple mycotoxins in one food sample
- Safety of some mycotoxin management methods are still questionable methods
• Analytical tests are expensive; there is a lack of expertise, or a limited number of laboratories performing the tests
• Regulations: not all are regulated, regulations for developing countries
• Turn-around times for results are generally poor: a farmer with production ready-for-the-market cannot afford to wait for 1 month for analytical test results
• Small-scale farmers or informal markets are not aware of the potential harm caused by mycotoxins
• There is an increasing stringent list of regulated mycotoxins, and laboratories are not always up-to-date with corresponding analytical tests
The Way Forward

- Establishment of more regulations
- Awareness creation

- Development of more adaptable strategies for mycotoxin management
- Analysis needs to be affordable, move more towards sensitive and faster screening tests
- Collaboration:
  “The true strength of our classroom lies in the collaboration of learners not in the knowledge of one expert”
CONCLUSION

- Mycotoxins are a chemically diverse group of fungal metabolites that have a wide variety of toxic effects.
- The development of practical control and management strategies is essential to ensure consumer safety.
- However, the mycotoxin contamination process is so complex that a combination of approaches will be required to eliminate or even control the problem.
- Continued research is required in these areas to provide more effective management of the risks posed by mycotoxin contamination.
- In the meantime, procedures that have proved effective for specific mycotoxins and/or commodities should be evaluated for other applications.
CONTACT
Ife Adekoya
Olotu.ifeoluwa@gmail.com

Thank you!!!!!