Aflatoxins and animal health:
Case studies from Africa

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PACA workshop

Engaging the Health and Nutrition Sectors in Aflatoxin Control in Africa

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ILRI INTERNATIONAL LIVESTOCK RESEARCH INSTITUTE

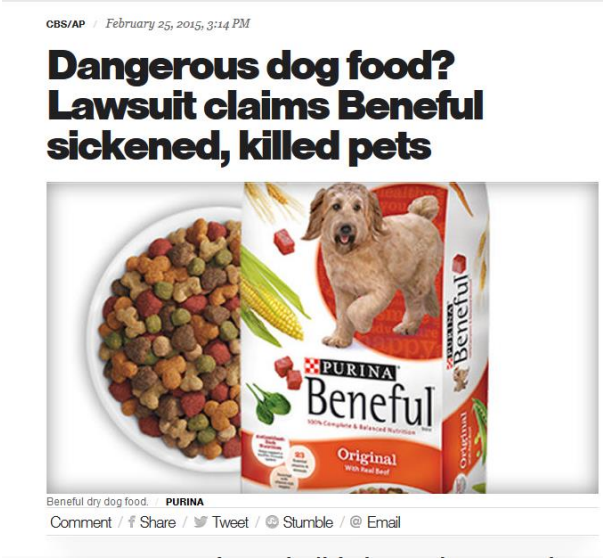
The talk today

- What are the consequences of aflatoxins in animals?
- Some results from our research on livestock
    - Kenya
    - Senegal
- Why do we need to focus research on livestock?

Why bother about aflatoxins and animals?

- Animals are susceptible to aflatoxins: some more, some less

1. Animal suffering- an animal welfare issue
2. Reduced animal productivity
3. Aflatoxins in animal-source foods



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Health effects observed

- Liver damage
- Gastrointestinal dysfunction, decreased appetite
- Immunosuppression
- Decreased reproductive function, decreased growth, and decreased production
- Carcinogenicity?

Feeding sheep 1,750 ppb aflatoxins for 3.5 years caused liver/nasal tumours

Highly susceptible: oral LD50 (<1 mg per kg body weight)

Rabbits, ducks, cats, swine, rainbow trout

Moderately susceptible: oral LD50 (1-2 mg per kg body weight)

Dogs, horses, calves, turkeys, guinea pigs, sheep, baboon

Relatively resistant: oral LD50 (5-10 mg kg body weight)

Chickens, rats, macaque monkeys, mouse, hamsters

One teaspoon of aflatoxin is enough to kill 2,500 rabbits

Reduced animal productivity

- Literature review show
  - Little research in Africa
  - Varying results
- Pigs: Increasing 1000 ppb in feed reduced growth gain with 3.9[a]-16[b]%
- AFB1 levels impairing production[c]: 800 ppb in chickens, 700 ppb in geese and quail, 500 ppb in duck and 400 ppb in Turkey

[a] **Andretta et al.** Meta-analytical study of productive and nutritional interactions of mycotoxins in growing pigs. Int J Anim Biosci. 2012;**6(9)**:1476–82.
[b] **Dersjant-Li et al.** The impact of low concentrations of aflatoxin, deoxynivalenol or fumonisin in diets on growing pigs and poultry. Nutr Res Rev. 2003;**16(2)**:223–39.
[c] **Monson et al.**. Aflatoxicosis: Lessons from Toxicity and Responses to Aflatoxin B1 in Poultry. Agriculture. Multidisciplinary Digital Publishing Institute; 2015;**5(3):**742–77.

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Safe levels?

- ≤50 in young poultry
- ≤100 in adult poultry
- ≤50 in weaned pigs
- ≤200 in finishing pigs
- <100 in calves
- <300 in cattle
- <100 in Nile tilapia

However depending on other factors!

Interactions

Mycotoxin	Main fungi	Impact on animal health
Aflatoxins	Aspergillus spp	All livestock susceptible to different degrees. Acute toxicity, hepatotoxic and nephrotoxic. Carcinogenic and mutagenic. Growth impairment. Immunosuppression.
Ochratoxin A	Aspergillus spp, Penicillum spp	Nephrotoxic Immunosuppression Possibly carcinogenic
Fumonisins	Fusarium spp	Toxic to liver and central nervous system Possibly carcinogenic
Zearalenone	Fusarium spp	Swine highly sensitive, cattle less sensitive. Endocrine disruption. Estrogenic effects, reduced reproduction, feminisation, malformations.
Trichotecenes	Fusarium spp	Gastrointestinal disturbance. Reduced feed intake. Ill-thrift. Immunosuppression.

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Standards and policies

FDA limits

product or animal	total aflatoxin action level (μg/kg)
human food	20
milk	0.5
beef cattle	300
swine over 100 lbs	200
breeding beef cattle, swine, or mature poultry	100
immature animals	20
dairy animals	20

Ref: Wu. VOL. 38, NO. 15, 2004 / ENVIRONMENTAL SCIENCE & TECHNOLOGY

Species	Range of aflatoxin limits ppb	Average aflatoxin limit ppb
All animals	5-300	48
Pigs	0-300	40
Cattle	0-300	41
Poultry	0-300	33
Sheep goats	5-75	26
Dairy	0-75	19
Duck/turkey/rabbit/trout	10-10	10

Animal source food

- Aflatoxins are transferred to animal products
- 1-7% of aflatoxins in feed is metabolized and transferred to milk
- Some studies show no transfer to eggs, other show low levels (5,000:1 -125,000:1)
- Meat intermediary transfer: around 1000:1 ?
    - Reduced if stop feeding

Kenya- dairy value chain

- Feed collected from 5 counties[a]
  - From farmers: 0.02 ppb to 9,661ppb and the positive samples ranged from 75% to 100%
  - Milk samples: Up to 6999ppt, up to 26% of samples
  - Samples exceeding 5ppb
    - 25% to 100% of the feed in farms
    - 85.7% to 100% of the feed from feed retailers
    - 20% to 100% of the feeds from feed manufacturers
  - Estimate cost of feed discarded if enforced: >20 billion USD
  - Estimated impact of this on lost milk production>30 million USD

[a] Mugangai et al. 2016, submitted

Kenya- urban milk

- Milk collected from milk retailers[a]
  - 58% knew about aflatoxin, but only 6% thought milk was not totally safe after boiling
  - Milk samples: mean AFM1 was 128.7 ppt, up to 1675 ppt. 55% of samples exceeded 50 ppt and 6% 500 ppt
- Child exposure study[b]
  - 41% of children were stunted
  - 98% of foods contained aflatoxin
  - AFM1 exposure associated with decreased HAZ

[a] Kiruni et al. 2016, submitted, [b] Kiarie et al. 2016, submitted

Senegal- dairy value chain

- Feed and milk- under analysis
  - Feed: highest levels in concentrate 305 ppb

Still many questions to answer

Interactions with other mycotoxins?

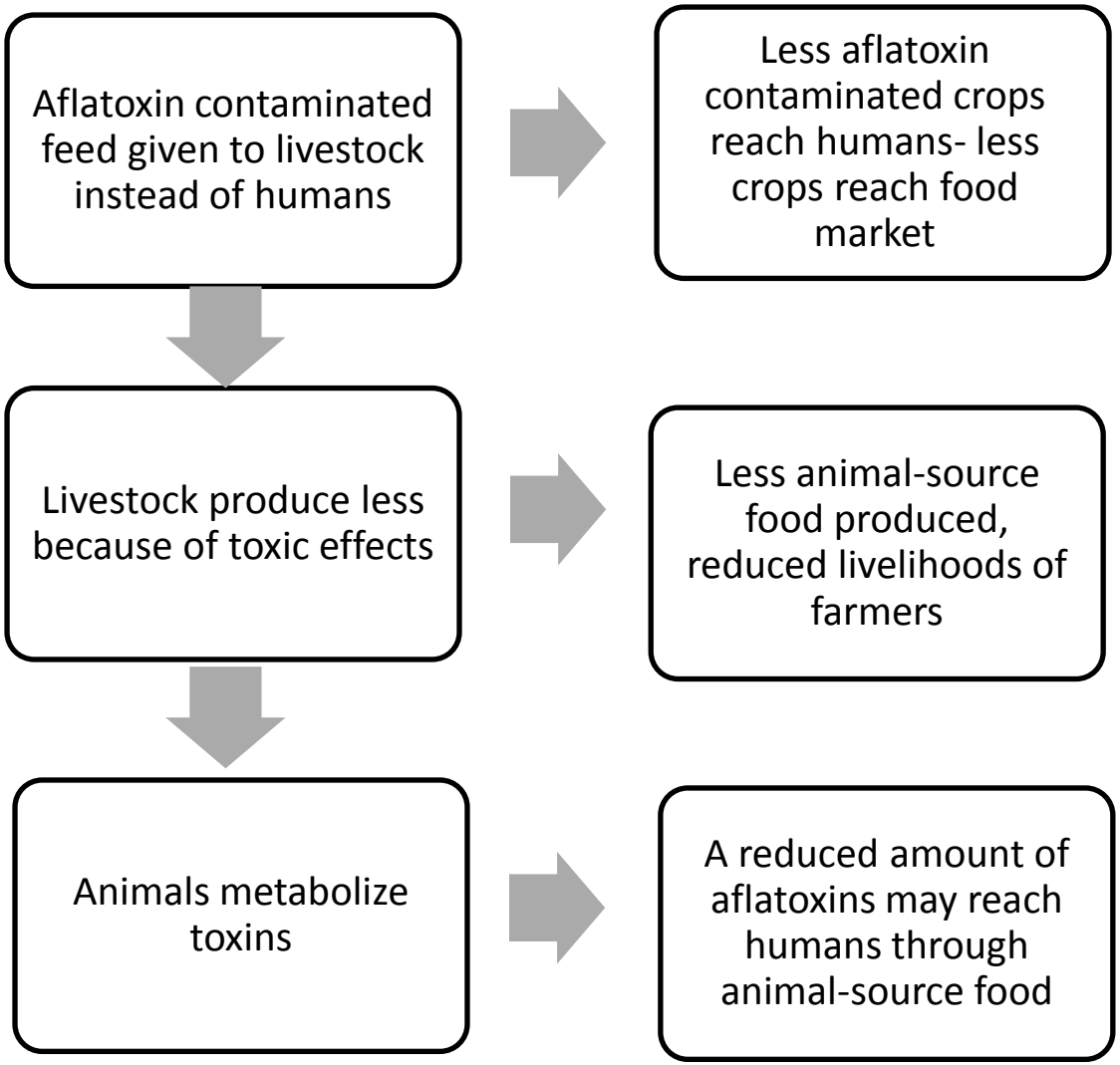
What are the most effective binders and mitigations?

Do we have the optimal regulations and how do we enforce them?

Objectives of feed standards

1. Protect humans from harmful aflatoxins in animal source foods
   - Milk is the most high risk animal source food because relatively large amounts of aflatoxins are carried over, and milk is consumed especially by infants
2. Safeguard the benefits people derive from livestock and fish by protecting valuable assets that provide multiple benefits
   - These include income, food and nutrition security, draft power, manure and social/cultural benefits
3. Protect value chain actors from fraudulent or defective products
4. Encourage fair trade, competition and economic growth through promoting standards and credibility
5. Safeguard the welfare of animals

Feeding livestock contaminated feed



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Standards for Anti-Mycotoxin Additives (AMAs) in Feeds

Clays (aluminosilicates)

- Most effective binder but different clays vary in effectiveness

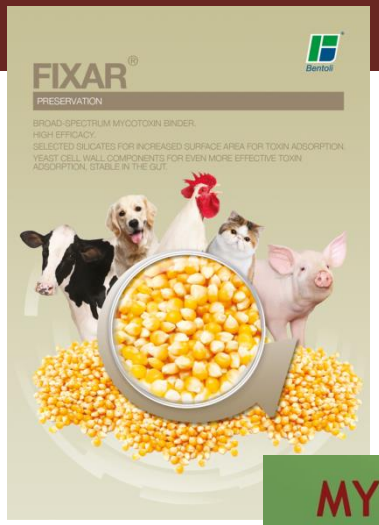
Yeast/bacterial cell wall extracts

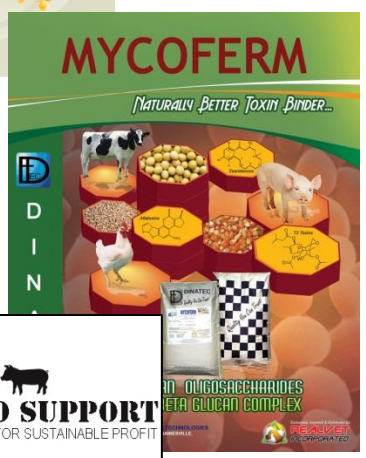
- Provide other useful nutrients, but evidence on effectiveness is mixed

Other binders

- Some are promising but less evidence of effectiveness

- *Over 100 companies offering AMAs*
- *In the Brazilian market, where approximately 100 AMAs for poultry and swine were evaluated, only about 30% were effective*





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Take home message

- Livestock is affected by aflatoxins, and so are animal-sourced food
- Research on full health impacts in animals, and economic consequences
- Livestock feed sector + binders an attractive mechanism to suck contaminated grain out of human food chain
- Potential for aflatoxin regulation to cause harm (burden on agricultural sector, concentrating contaminated among poorest)

Conclusions

There is no silver bullet to eradicate aflatoxins

-A battery of interventions to provide safer food in a world full of food safety hazards!

Animals may be both part of the problem and part of the solution

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