Mycotoxin binders
An option for safer milk in Kenya?

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Aflatoxins are toxic substances produced by certain species of moulds.

Best-characterised of many mould toxins in food and feed.

Common in Kenya (human outbreaks / much food and most feed above permissible levels).

**AFB1**: most common / toxic in humans and animals.
• Exposure to cows is through contaminated feed
• Contamination: use of spoilt raw materials, poor feed storage practices, giving food thought unfit for humans to animals
• Exposure to humans is through contaminated milk and milk products
The link between AFB1 in feed and release of AFM1 in milk

Feed
- Feed with AFB1 is given to cows

In the rumen
- AFB1 is broken down in the rumen and metabolites removed (waste)
- A fraction of AFB1 is absorbed / reaches the liver

In the liver
- AFB1 is broken down to a reactive (toxic) form
  - DNA binding (mutagenic/carcinogenic)
  - protein / RNA binding (cell processes disrupted)
- detoxified to less toxic forms (AFM1 in milk)
• AFM1 is the main AFB1 metabolite in milk; \textit{a carry-over rate of 1-7\% has been reported}~

• Other ASF (except sun-dried, secondarily contaminated) much less carry-over

• Why focus on AFM1? It \textit{retains \~10\% of AFB1 effects (health); high milk consumption rates; infant}
Very little aflatoxin is transferred to animal tissue or eggs

Ratios of aflatoxin in feed to that in edible animal tissues and products

<table>
<thead>
<tr>
<th>Animal</th>
<th>Tissue</th>
<th>Aflatoxin</th>
<th>Feed/Tissue ratio (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chicken (Layer)</td>
<td>Egg</td>
<td>B₁</td>
<td>2,200&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Chicken (Broiler)</td>
<td>Muscle</td>
<td>B₁</td>
<td>33,800&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Swine (Pigs)</td>
<td>Muscle</td>
<td>B₁</td>
<td>182&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cattle (Dairy)</td>
<td>Milk</td>
<td>M₁</td>
<td>75&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Cattle (Beef)</td>
<td>Muscle</td>
<td>B₁</td>
<td>500&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

<sup>a</sup>Adapted from Park and Liang. 1993; <sup>b</sup>Adapted from Manning et al. 2005

• Variable susceptibilities (species, age, status etc.): <100ppb (calves); <300ppb (cattle); are more tolerant than humans

• Acute toxicity, hepatotoxic, nephrotoxic, carcinogenic, mutagenic, immuno-suppression, growth impairment
Regulations and standards

• AF standards (food / feed) are necessary to protect health (human, animals) [..compliance issues]

• Milk use in child nutrition demands stricter AFM1 standards (which is also variable, **0.05 ppb (EU); 0.5 ppb (FDA); EAC limit is 0.05 ppb**)

*Standards that are “too strict” can impact on food security / trade*
Many countries allow higher aflatoxin in feed than in food for human consumption

<table>
<thead>
<tr>
<th>Commodity</th>
<th>For consumption by</th>
<th>EU</th>
<th>USA</th>
<th>Kenya</th>
<th>Ghana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize</td>
<td>Humans</td>
<td>4</td>
<td>20</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Groundnut</td>
<td>Humans</td>
<td>4</td>
<td>20</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Maize</td>
<td>Immature animals</td>
<td>10</td>
<td>20</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Maize</td>
<td>Mature animals</td>
<td>20</td>
<td>100</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Maize</td>
<td>Mature feedlot cattle</td>
<td>20</td>
<td>300</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Maize</td>
<td>Dairy cattle</td>
<td>5</td>
<td>20</td>
<td>10</td>
<td>15</td>
</tr>
<tr>
<td>Milk</td>
<td>Humans</td>
<td>0.5</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>Milk</td>
<td>Infants</td>
<td>0.025</td>
<td>0.5</td>
<td>0.5</td>
<td></td>
</tr>
</tbody>
</table>
Assessment of standards

• Rarely evidence-based
  – Some have zero standards
  – Not related to consumption or liver cancer risk
  – Not related to species vulnerability
  – Very little enforcement in LMIC

• Tend to ratchet-up

• Countries with more aflatoxins tend to have laxer standards
Mitigation strategies

• Several approaches exist (pre- and post harvest) but none, on its own, is adequate

• Mycotoxin binders, applicable at the level of animal feeding, are one such options

• Are mainly clays \textit{(aluminosilicates—e.g. hydrated sodium calcium aluminosilicate \textit{(HSCAS)} or yeast /bacterial cell wall extracts}
How mycotoxin binders work in dairy (1)

• Binders are mixed with feed, and when ingested by cows, bind the toxins in the gastro-intestinal tract of the animal.

• Bound toxins are eliminated in faeces and their bio-availability is reduced.

• The cow is protected from ill effects and safer milk is produced
How mycotoxin binders work in dairy (2)

- Many different binders are marketed worldwide

- Their effectiveness varies by type and amount used, and some may not be effective in binding aflatoxins

- Effectiveness of NovaSil® (an HSCAS) has been demonstrated in many studies: 0.5-1kg/tonne of feed
Which mycotoxin binders are available in Kenya

• ILRI study – visits to agrovet and animal feed outlets (Nairobi / Kisumu)

• Focused on binder types sold / used in animal feeds.

Availability and use of mycotoxin binders in selected urban and Peri-urban areas of Kenya

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<table>
<thead>
<tr>
<th>Description</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Imported as</strong></td>
<td>Feed additives</td>
</tr>
<tr>
<td><strong>Types</strong></td>
<td>9 different types</td>
</tr>
<tr>
<td><strong>Sources within the country</strong></td>
<td>Agrovets, feed millers</td>
</tr>
<tr>
<td><strong>Who buys</strong></td>
<td>Smallholders for home feed formulation; feed millers</td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>Variable depending on binder type</td>
</tr>
</tbody>
</table>
Our observations (2)......

- Feed millers source raw materials from distant places with high likelihood of spoilage during handling, transportation and storage
- Awareness about mycotoxin binders is low; and their inclusion in feed is not regular
- There are no standards that govern the use of mycotoxin binders in Kenya
- The products include substances that are unknown
Our observations (3)...

https://www.biomin.net/en/products/mycofix/
Our conclusions (1)

- Relaxing aflatoxin standards in feed for meat animals may be appropriate
- Mycotoxin binders can reduce pass-through of aflatoxin to milk
- Mycotoxin binders are an option to reducing risk of aflatoxin exposure
- Their effectiveness, when used in local smallholder systems (e.g. quantities for feed batches of different contamination levels), need to be investigated
- Findings from such studies can be used to inform development of standards for their use in the country
Conclusions (2)

- Binders are sold in large quantities (~25kg) which may be expensive for smallholders.
- Marketing approaches that meet the need of all producers *(home feed formulation, purchased feeds etc.)* need to be explored.
- Binders are not a stand-alone strategy and raising awareness on other mitigation approaches is equally important.
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