Human health effects of aflatoxins

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Health effects

• High (acute) levels of contamination (above 200 ppb)
  • Direct outbreak of human disease e.g. Aflatoxicosis
  • Acute illness and death, usually through liver cirrhosis

• Low (chronic) levels of contamination
  • Child stunting and underweight
  • Immune suppression

• Acute and chronic contamination
  • Liver cancer
Mechanism of toxicity/carcinogenicity

• Specific enzymes in the liver metabolise aflatoxins into a reactive oxygen species (ROS)
• The ROS may bind to proteins and cause acute toxicity
• The ROS may also bind to DNA to cause lesions that over time increase the risk of liver cancer
# Aflatoxicosis in Kenya

<table>
<thead>
<tr>
<th>Year</th>
<th>Incident</th>
</tr>
</thead>
<tbody>
<tr>
<td>1981, 1985</td>
<td>12 people died in Machakos district</td>
</tr>
<tr>
<td>2001</td>
<td>26 people were admitted to Maua Methodist Hospital, 16 of them died</td>
</tr>
<tr>
<td>2004</td>
<td>123 people died after consuming aflatoxin contaminated maize in Eastern and Central provinces</td>
</tr>
<tr>
<td>2005</td>
<td>Over 20 people died of fatal aflatoxicosis</td>
</tr>
<tr>
<td>Between 2000 and 2008</td>
<td><strong>265 people died</strong></td>
</tr>
</tbody>
</table>
A lot of cases are not reported or investigated

- **What should be done?**
  - Raise awareness on aflatoxin outbreaks
  - Include aflatoxin exposure in national food borne surveillance systems
  - Build capacity to investigate aflatoxin outbreaks (provide diagnostics and human resources)
Liver cancers cases attributable to aflatoxins (Liu and Wu 2010)

- Naturally occurring mixes of aflatoxins have been classified as group 1 human carcinogen
- 25,200 – 155,000 cases are attributable to aflatoxins
  - This is up to 28.2% of all global liver cancers
- Most cases occur in sub Sahara Africa, Southeast Asia and China
- These regions suffer from high Hepatitis B virus (HBV) infection and uncontrolled aflatoxins in foods
Global prevalence of chronic Hepatitis B virus infection 1997
HBV infection contributes to liver damage that is potentiated by chronic aflatoxin exposure

- The virus may interfere with aflatoxin metabolism and detoxification process
- HBV-infected hepatocytes are prone to aflatoxin induced DNA damage
- Replication of the virus may contribute to the mutation potentiated by aflatoxins
Risk for primary liver cancer attributable to aflatoxins:

Exceeds 1 case per year per 100,000 people

<table>
<thead>
<tr>
<th>Country</th>
<th>HBV positive (Cases/year/100,000 people)</th>
<th>HBV negative (Cases/year/100,000 people)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mozambique</td>
<td>54</td>
<td>1.8</td>
</tr>
<tr>
<td>Nigeria</td>
<td>68.1</td>
<td>2.27</td>
</tr>
<tr>
<td>Kenya</td>
<td>39.9</td>
<td>1.33</td>
</tr>
<tr>
<td>Tanzania</td>
<td>15.0</td>
<td>0.5</td>
</tr>
<tr>
<td>USA</td>
<td>0.008</td>
<td>0.003</td>
</tr>
</tbody>
</table>

The risk for HBV positive is up to 30 times higher than for HBV negative (Liu and Wu 2010)
Risk of liver cancer is very high in Africa and is related to high aflatoxin exposure \cite{Shephard2008}

<table>
<thead>
<tr>
<th>Country (food item)</th>
<th>Food intake (g/person/day)</th>
<th>Exposure (ng/kg body weight/day)</th>
<th>Risk (Cases/year/100,000 people)</th>
<th>MoE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya (Maize)</td>
<td>400</td>
<td>353</td>
<td>29.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Ghana (Kenkey)</td>
<td>1000</td>
<td>850</td>
<td>70.1</td>
<td>0.2</td>
</tr>
<tr>
<td>Tanzania (Local brew)</td>
<td>1048</td>
<td>402</td>
<td>33.1</td>
<td>0.4</td>
</tr>
<tr>
<td>Gambia (Groundnuts)</td>
<td>65</td>
<td>16</td>
<td>1.3</td>
<td>10.6</td>
</tr>
</tbody>
</table>

- Risk exceeds 1 case per year per 100,000
- Margin of Exposure (MoE) is lower than 10,000
Options to reduce aflatoxin induced cancer burden

• Vaccinate against HBV
  • Success has been observed in the EU, Taiwan and Thailand
• Minimize aflatoxins exposure from foods
  • Reduce contamination
  • Reduce consumption
  • Reduce both contamination and consumption
Challenges for exposure reduction

• Reliance on one or two crops for food
• High occurrence of aflatoxins in the foods (staples)
• Low level of awareness on the problem of aflatoxins contamination and potential mitigation measures
• Low capacity for risk assessment and management for aflatoxins
Population liver cancer risk (cancers per 100,000 population) for different food intakes at different aflatoxin B1 contents *(Shaphard 2008)*

<table>
<thead>
<tr>
<th>Aflatoxin B1 (ng/g)</th>
<th>10</th>
<th>50</th>
<th>100</th>
<th>150</th>
<th>200</th>
<th>400</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.014</td>
<td>0.069</td>
<td>0.14</td>
<td>0.21</td>
<td>0.28</td>
<td>0.55</td>
</tr>
<tr>
<td>2</td>
<td>0.028</td>
<td>0.14</td>
<td>0.28</td>
<td>0.41</td>
<td>0.55</td>
<td>1.1</td>
</tr>
<tr>
<td>5</td>
<td>0.069</td>
<td>0.34</td>
<td>0.69</td>
<td>1</td>
<td>1.4</td>
<td>2.8</td>
</tr>
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<td>0.14</td>
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<td>2.1</td>
<td>2.8</td>
<td>5.5</td>
</tr>
<tr>
<td>20</td>
<td>0.28</td>
<td>1.4</td>
<td>2.8</td>
<td>4.1</td>
<td>5.5</td>
<td>11</td>
</tr>
</tbody>
</table>

The blue colour values represents risk of concern (above 1 per 100,000)
Conclusions

- Risk of aflatoxins exposure in Africa is very high (MoE < 10 in most countries)
- Risk of liver cancer attributable to aflatoxins in Africa is unacceptably high (More than 1 case per year per 100,000 people)
- Take urgent preventive measures:
  - Incorporate HBV vaccination in national vaccination programs
  - Diversify our diets to include foods that are less susceptible to aflatoxins
- Initiate aflatoxins control programs:
  - Raise awareness on aflatoxins
  - Build capacity for aflatoxins risk assessment, management and communication
  - Include aflatoxin exposure in national food borne surveillance systems
Thank you