Occupational health exposures and potential risks of Aflatoxins

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Moulds (Aflatoxins) in feedmills
Grow in damp, or decaying organic material
Produce large numbers of spores
Can be inhaled
Air-borne exposure results in allergy
Some fungi produce mycotoxins
Mycotoxins are secondary metabolites
Mycotoxins affect 25% World crops (Var & Kabak, 2004)

Foods such as cereals (MAIZE), nuts (GROUNDNUTS) provide excellent substrate for mycotoxin elaboration

Major raw materials for industries & feedmills are maize & groundnut
INTRODUCTION (Cont.)

Plate 1: Mouldy Maize & Groundnut
Sources of mycotoxins: dietary and air borne

Microorganisms: *Aspergillus flavus* & *A. parasitus*

Aflatoxins are known as class 1 carcinogens

14.1 million new cancer cases world wide (American Cancer Society, 2015)

8.2 million deaths in 2012 world wide (American Cancer Society, 2015).

Local animal feeds have high aflatoxin levels (Oluwafemi *et al.*, 2010)

Aim of study was on occupational aflatoxin exposures & potential risks
Fig. 1 Structure of Aflatoxin B1
Table 1. Macroscopic and Microscopic Identification of isolated fungal species

<table>
<thead>
<tr>
<th>Macroscopy</th>
<th>Microscopy</th>
<th>Organism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brownish green filamentous colonies</td>
<td>Septae wall, rough spore head, fruiting conidiophores, presence of metullae</td>
<td>A. flavus</td>
</tr>
<tr>
<td>Yellowish–green filamentous colonies</td>
<td>Conidia smooth and globose, uniseriate metulae absent</td>
<td></td>
</tr>
<tr>
<td>Deep-green colonies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dull green filamentous colonies</td>
<td>Conidia smooth and globose, uniseriate metulae absent</td>
<td>A. fumigatus</td>
</tr>
<tr>
<td>Greenish carpet-like colonies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Black filamentous colonies</td>
<td>Biseriate, presence of metulae, rough conidia</td>
<td>A. niger</td>
</tr>
<tr>
<td>White fluffy colonies</td>
<td>Broad aseptae, hyphae seen (rhizoid) with sporangiophore</td>
<td>Rhizopus spp</td>
</tr>
<tr>
<td>Grey white filamentous colonies</td>
<td>Smooth spores, presence of metulae and conidiospores</td>
<td>A. terreus</td>
</tr>
<tr>
<td>Pale orange colonies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Creamy white colonies</td>
<td>Biseriate, presence of metulae</td>
<td>A. candidus</td>
</tr>
</tbody>
</table>
Table 2. Concentration of aflatoxin (ng/g) in plates exposed in various feedmills

<table>
<thead>
<tr>
<th>Aflatoxin Type</th>
<th>A1</th>
<th>A2</th>
<th>B1</th>
<th>B2</th>
<th>C1</th>
<th>C2</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>6.91</td>
<td>125.0</td>
<td>65.0</td>
<td>37.2</td>
<td>71.3</td>
<td>118</td>
</tr>
<tr>
<td>B2</td>
<td>0.10</td>
<td>0.10</td>
<td>0.11</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>G1</td>
<td>-</td>
<td>1.50</td>
<td>1.14</td>
<td>0.57</td>
<td>-</td>
<td>0.09</td>
</tr>
</tbody>
</table>
### RESULTS (Cont.)

Table 3. Aflatoxin concentration (ng/g) in the body fluid (blood) of feed mill workers

<table>
<thead>
<tr>
<th>Aflatoxin type</th>
<th>Aflatoxins in serum of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A</td>
</tr>
<tr>
<td>B1</td>
<td>106.7</td>
</tr>
<tr>
<td>B2</td>
<td>-</td>
</tr>
<tr>
<td>G1</td>
<td>-</td>
</tr>
<tr>
<td>G2</td>
<td>-</td>
</tr>
</tbody>
</table>
Table 4. Mean aflatoxins (ng/g) in fungi isolates, feed-mill and non feed-mill workers

<table>
<thead>
<tr>
<th>Aflatoxin type</th>
<th><em>A. flavus</em> isolate</th>
<th>workers</th>
<th>Non- workers</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>143.7</td>
<td>129.0</td>
<td>-</td>
</tr>
<tr>
<td>B2</td>
<td>0.148</td>
<td>0.45</td>
<td>0.25</td>
</tr>
<tr>
<td>G1</td>
<td>1.870</td>
<td>1.12</td>
<td>2.1</td>
</tr>
<tr>
<td>G2</td>
<td>-</td>
<td>1.77</td>
<td>1.1</td>
</tr>
</tbody>
</table>
Aflatoxins were detected in exposed plates

Aflatoxin levels range from 30-583ng/g

Mean Aflatoxins in exposed plates 189.13ng/g

Factors: high humidity, inadequate ventilation, air tightness of the building, dampness, aerosols from raw ingredients

AFB1 of workers range from 49-227ng/g
Results due to workplace exposure and diet

- Aflatoxins recorded in case-control could be through ingested food
- Aflatoxins are class 1 carcinogens
- Spores possess potent surface antigens capable of eliciting allergic reactions
- Patients may exhibit rhinitis, bronchial asthma, alveolitis or generalized pneumonitis
- Feed mill workers should always use protective device (nose cover)
Maize grains----1, 200µg/kg

Groundnut------1, 700µg/kg (Emerole et al., 1982)

Peanut oil--------500ng/ml

Melon seed (Egusi)------1400µg/kg (Bankole et al., 2004)

Yam chips----------4-18 µg/kg (Bankole & Adebanjo, 2003)
Aflatoxins in human serum and semen range between 50-1450 ng/ml (Onyemelukwe & Ogbadu, 1981; Denning et al., 1988; Oluwafemi, 2000)

Aflatoxins in blood of feedmill workers range between 49-227 ng/ml (Oluwafemi et al., 2011)

Aflatoxin M1 in breast milk of lactating mothers range between 2-187 ng/ml (Oluwafemi & Ibeh, 2011)

Aflatoxin M1 in weaning foods (mainly maize-based) range between 4.6-530ng/g (Oluwafemi & Ibeh, 2011)

Aflatoxins (19µg/kg) found 12 maize-based gruels contaminated with aflatoxin (Oyelami et al., 1996)
POTENTIAL HEALTH RISKS OF AFLATOXINS

TOXICOLOGY

- Dose Effects: High doses lethal if consumed. Affects lung, myocardial & kidney tissues (Vismer, 2007)
- Sub-lethal doses: chronic toxicity e.g. liver cirrhosis
- Low level exposure: human hepatocellular carcinoma
Impaired growth in children (Gong et al., 2002, 2004; Oluwafemi & Taiwo, 2004)

More than ½ of children in Chad are stunted (UNICEF, 2013)

39% of children under five in the developing world are stunted – around 209 million children. Stunting rates are highest in Asia and sub-Saharan Africa (UNICEF, 2013)
Fig. 2: World wide stunted children

Source: UNICEF, 2013
Aflatoxin associated with kwashiorkor in children (Rotimi et al., 2015)

Synergistic with Hepatitis B virus to cause liver cancer

30 times more potent in HBV+ people

5-60 times higher cancer risk. 160 million cancer cases due to Aflatoxin
POTENTIAL RISKS OF AFLATOXINS

- Mutagenicity: AFB1 binds covalently to DNA (Rotimi et al., 2015)
- Teratogenicity: Embryonic abnormalities
- Immunosupression: Immunodiluting agent-cell mediated immunity and phagocytic cell function (Bondy & Pestka, 2000)
- Enhance susceptibility to infection (Turner et al., 2003)
POTENTIAL RISKS OF AFLATOXINS (Cont.)

- Impede nutrient uptake and utilization of micronutrients in human systems
- Plays contributory role in infertility (Oluwafemi, 2000)
- Simulated doses reveal gross liver necrosis (Oluwafemi & Taiwo, 2004)
CONCLUSION

No tolerable dose of aflatoxins can be approved. There is no dose that cannot stimulate harmful effects. Low technologies such as fermentation, use of imarsil adsorbents, nose cover, local spices and modified atmosphere storage should be adopted by low income countries in Africa. Most importantly Awareness is needed in Africa.
SELECTED REFERENCES


THANK YOU