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Fumonisins in South African subsistence maize - A single kernel approach

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Publication date:
2011

Document Version
Publisher's PDF, also known as Version of record

Link back to DTU Orbit

Citation (APA):
Fumonisins in South African subsistence maize - A single kernel approach

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Introduction:
Fumonisins are a group of naturally occurring, polyketide-derived mycotoxins produced mainly by Fusarium verticillioides and Fusarium proliferatum. Recently fumonisins B1 and B2 have also been detected from Aspergillus niger and Tolyposidium. Fumonisins constitute an important health risk because they are carcinogenic and cause various toxicoses in humans and animals. Fusarium species occur world-wide in maize where they infect the cob during flowering. They can produce high amounts of fumonisins in tropical and subtropical regions.

Maize is the staple cereal food grown and consumed by the rural farming communities of Africa and especially in the Transkei region in South Africa. The Transkei region has one of the highest esophageal cancer mortality and incidence rates in the world which seems to be associated with the fumonisin intake. In this study we survey the fumonisin content in single maize kernels to establish the effects of manual visual sorting as well as determine if these kernels actually contain fumonisins.

Methods

Extraction of kernels
The kernels were surface sterilized in 0.4% sodium hypochlorite for 2 minutes; afterwards the kernels were washed in water. A 2% water agar was used for the P. aurantiogriseum, P. crustosum, P. pittii and P. brevicompactum as well as the Fusarium species were isolated, although some of the fungi were identified as unknown. The contamination of the maize kernels were determined by plating 60 visibly infected or damaged kernels on water agar per batch, in 240 kernels. Plates were incubated for 7 days at 25 °C.

An in vitro method was used for determination of the fumonisin B1, B2, B3 and B4 content. The fumonisin concentration was lower by 71% by removal of 4% of contaminated kernels. The kernels were sorted out by the subsistence farmers, and the number of infected kernels were determined. A more thorough sorting of the subsistence grown maize kernels is essential in order to decrease the fumonisin concentration.

Results & Discussion:

From visibly infected or damaged kernels primarily only F. subglutinans and F. verticillioides were isolated, although P. concavorugulosum, A. wentii, Eurotium sp., P. aurantiogriseum, P. crustosum, P. pittii and P. brevicompactum were also present at a low number.

When single kernels were analyzed, all 10 batches (5 good and 5 moldy as sorted by the farmers) contained positive kernels. Of the 400 tested kernels, 59 (15%) were positive for fumonisins (FB1, FB2, FB3, and FB4) and 15 (<4%) of these were contaminated with A. wentii. Of the 400 tested kernels, 59 (15%) were positive for fumonisins (FB1, FB2, FB3, and FB4) and 15 (<4%) of these were contaminated with A. wentii. Of the 400 tested kernels, 59 (15%) were positive for fumonisins (FB1, FB2, FB3, and FB4) and 15 (<4%) of these were contaminated with A. wentii. Of the 400 tested kernels, 59 (15%) were positive for fumonisins (FB1, FB2, FB3, and FB4) and 15 (<4%) of these were contaminated with A. wentii.

Total FB content were calculated from the infection rate, mean kernel weight, batch weight, and mean fumonisin concentration. The fumonisin concentration could be lowered by 71% by removal of 4% of the contaminated kernels. The strategy of sorting out visibly infected kernels has recently been successful applied in an intervention study in the same rural Transkei area resulting in a mean fumonisin reduction of 84% by removing a mean of 3.0% by weight. A more thorough sorting of the subsistence grown maize kernels is necessary in order to decrease the fumonisin concentration.

Table 1: Infection rate of batches and fumonisin (FB) content in infected and uninfected maize kernels

<table>
<thead>
<tr>
<th>Infection Rate</th>
<th>FB1 (mg/kg)</th>
<th>FB2 (mg/kg)</th>
<th>FB3 (mg/kg)</th>
<th>FB4 (mg/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uninfected</td>
<td>5.2</td>
<td>4.3</td>
<td>0.7</td>
<td>0.5</td>
</tr>
<tr>
<td>Infected</td>
<td>12.1</td>
<td>10.4</td>
<td>2.2</td>
<td>1.6</td>
</tr>
</tbody>
</table>

Conclusion

- Fumonisin contamination is primarily caused by F. verticillioides and F. subglutinans.
- Single kernels contained up to 1.4 ‰ Fumonisin B1, B2, B3 and B4.
- The fumonisin concentration could be lowered by 71% by removal of 4% of the kernels.
- A more thorough sorting of the subsistence grown maize kernels is essential in order to decrease the fumonisin concentration.

References