Gibberella Ear Rot and Mycotoxins in Corn
Sampling, Testing, and Storage

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Gibberella ear rot and vomitoxin

Gibberella ear rot is caused by the fungus Gibberella zeae (also known as Fusarium graminearum), the same pathogen that causes stalk rot of corn and head scab of wheat. The fungus typically infects via the silk channel, causing a pinkish-white mold to develop at the tip of the ear (fig. 1). Cool, wet weather (rainfall or high relative humidity) during and after silking (R1 growth stage) provides optimal conditions for the development of ear rot. During infection and colonization of the ear, the fungus produces several mycotoxins, including deoxynivalenol (DON), also called vomitoxin. As a result, high levels of Gibberella ear rot severity and moldy grain are usually accompanied by high levels of vomitoxin.

Mycotoxins are harmful to both humans and animals. Vomitoxin is water soluble, heat stable, and is the most commonly encountered mycotoxin in food and feed. Grain should be analyzed for toxins before being fed to animals. As a general rule do not feed any grain with >5% moldy kernels. Swine and young animals are particularly sensitive to mycotoxins. As the name suggests, vomitoxin provokes vomiting and may also cause feed refusal and suppression of the immune system. Proper sampling and testing are necessary to determine accurate vomitoxin levels in grain.

The U.S. Food and Drug Administration (FDA) established advisory guidelines for vomitoxin to ensure the safety of the food and feed supply.

Vomitoxin variability in infected grain

The number of ears infected within a field and number of infected kernels on a given ear are highly variable. Kernels with similar appearance in terms of surface moldiness may have different levels of internal fungal colonization, and consequently, variation in mycotoxin production. Healthy-looking kernels may also be contaminated. As a result, moldy grain and vomitoxin levels vary considerably within the grain.

<table>
<thead>
<tr>
<th>Species</th>
<th>Maximum Tolerable Levels</th>
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<tbody>
<tr>
<td>Humans</td>
<td>1 ppm in finished flour</td>
</tr>
<tr>
<td></td>
<td>1 ppm in total diet</td>
</tr>
<tr>
<td>Swine</td>
<td>1 ppm in total diet</td>
</tr>
<tr>
<td>Ruminants &amp; Chickens</td>
<td>10 ppm in 50% of diet</td>
</tr>
<tr>
<td></td>
<td>(5 ppm in total diet)</td>
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<tr>
<td>Other Animals</td>
<td>2 ppm in total diet</td>
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Figure 1. A corn ear displaying Gibberella ear rot symptoms.
lot. There are always “hot spots” and these may affect the accuracy of sampling and testing for vomitoxin. For instance, if a single sample is drawn and the location from which it is drawn happens to be a hot-spot, then the level of contamination of the lot will be overestimated. Conversely, if the sample misses the hot spots completely, vomitoxin contamination may be underestimated.

**Sampling for mycotoxins**

Accurate testing depends on thorough and appropriate sampling. Poor sampling may result in considerable variation in test results, and could be the cause of some grain rejections. Guidelines for grain sampling, based on research with scabby wheat and barley, are available from the United States Department of Agriculture Grain Inspection, Packers and Stockyards Administration (GIPSA).

To collect a representative grain sample, 5–10 samples should be randomly collected from multiple locations in the bin or truckload. Samples taken only from the central or outer portions of the load or from the beginning and end of the grain stream will not provide an accurate estimate of toxin contamination. For end-gate sampling, samples should be drawn from the entire width and depth of the grain stream. For sampling with hand or mechanical probes, multiple samples should be drawn from throughout the bin or truck, along an X-shaped pattern, for example. Once samples are obtained, bulked, and cleaned, the grain must be ground uniformly, in a clean grinder, to resemble flour. Finer particle size increases surface area of the grain and enables efficient extraction of vomitoxin.

**Mycotoxin test options**

There are three general types of mycotoxin tests: qualitative, semi-quantitative, and quantitative. Qualitative tests provide a yes/no answer for the presence of vomitoxin and are useful for initial screening steps. Semi-quantitative tests estimate vomitoxin at or above certain levels (>5 ppm) or within a given range, whereas, quantitative tests provide more precise vomitoxin estimates. There is a trade-off between precision, price, and speed. The more quantitative tests tend to be the most precise, but are also more expensive and take longer to complete than the qualitative or semi-quantitative tests. Common vomitoxin testing methods and their pros and cons are highlighted here:

<table>
<thead>
<tr>
<th>Method</th>
<th>Pros</th>
<th>Cons</th>
</tr>
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<tbody>
<tr>
<td><strong>Near-Infrared Light</strong></td>
<td>• PRO: Very quick. Performed with whole kernels.</td>
<td>• CON: Indirect (measures kernel damage rather than toxin itself). Extensive calibration required.</td>
</tr>
<tr>
<td><strong>Chromatography</strong></td>
<td>• PRO: Very accurate and quantitative.</td>
<td>• CON: Expensive! Requires specialist expertise.</td>
</tr>
</tbody>
</table>

Semi-quantitative mycotoxins tests such as ELISA are very common at grain elevators, and when used correctly, are quite accurate since they are usually engineered and calibrated against quantitative tests such as chromatography. However, ELISA-based tests are usually very specific. The kit is specifically for one particular toxin. To detect other toxins, such as zearalenone or aflatoxin, additional tests must be used. Furthermore, the test must be approved for
the commodity to be analyzed (corn, dried distillers grains, wheat, barley, etc).

USDA-GIPSA has approved several different types of test kits that test corn, wheat, oats, and barley for vomitoxin. A list of these kits can be found in the DON (Vomitoxin) Handbook. Grain samples may also be sent to a laboratory providing vomitoxin analysis.

Vomitoxin testing law: a second opinion

Poor sampling and/or testing technique may lead to incorrect estimation of vomitoxin in the grain lot. Prior to testing, producers (or their agents) may request a second sample be drawn if they feel the first sample was not representative of the entire lot. Following vomitoxin testing, producers/agents have the right to reject the commodity testers’ results and order the handler to send the sample to a federally licensed grain inspector for a re-test. Refer to Ohio Code 926.31 for details.

Minimizing the risk of vomitoxin in storage

Toxin levels can increase in storage if conditions are not dry and cool. Warm, moist pockets in the grain promote mold development, causing the grain quality to deteriorate and toxin levels to increase. Aeration is important to keep the grain dry and cool. However, it should be noted that while cool temperatures, air circulation, and low moisture levels will minimize fungal growth and toxin production, these will not decrease the level of toxin that was already present in grain going into storage. Vomitoxin is very stable and will not be reduced with drying.

Selected references

- Laboratories providing DON analyses. www.oardc.ohio-state.edu/ohiofieldcropdisease/wheat/mycotoxin%20text2.htm

**Storage Guidelines for Ear Rot-Affected Corn**

- Harvest at the correct moisture and adjust harvest equipment to minimize damage to kernels. Mold and mycotoxins tend to be higher in (machine or insect) damaged kernels.
- Dry and store harvested grain to below 15% moisture to minimize further mold development and toxin contamination in storage.
- Store dried grain at cool temperatures (36 to 44°F) in clean, dry bins. Moderate to high temperatures are favorable for fungal growth and toxin production.
- Periodically check grain for mold, insects, and temperature.
- If mold is found, send a grain sample for mold identification and analysis to determine if toxins are present and at what level.
- Clean bins and storage units between grain lots to reduce cross-contamination.

**Black Light (UV) Testing**

A black light cannot detect vomitoxin since this toxin does not fluoresce. This is not an accurate test for any toxin (including aflatoxin), as there are natural compounds in grain that fluoresce under black light.

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