Trilogy Analytical Laboratory

Effects of Particle Size and Extraction Size for Effective Mycotoxin Analysis

Julie Brunkhorst
Trilogy Analytical Laboratory

Where are We?

Trilogy is located in Washington, Missouri –

about 50 miles west of St. Louis
Introduction to Trilogy Analytical Laboratory

- Mycotoxins, Drug Residues, Biogenic Amines and Allergen analysis of food, feed, beverages and pharmaceuticals
- Clients from industry, government, manufacturing, laboratories, and producers
- ISO 17025 and ISO 9001 accredited
**Mycotoxin Services**
- Mycotoxin Analysis on food, feed, beverages and pharmaceuticals
- Approximately 15,000 – 30,000 analysis per month
- Operating 3 GC systems, 17 HPLC/UPLC’s and 2 LCMSMS systems

**LCMSMS systems – Sciex 5500 Qtrap and Sciex 6500 Qtrap**
- 5500 is primarily used for Drug Residue Analysis and used as a second instrument for mycotoxin analysis
- 6500 is used for Mycotoxin sample analysis and also Mycotoxin Standard analysis
**Education** – Everyone is involved. This seems pretty simple – but here are real examples.

Yep we have to get at least 5 pounds – the lady said…… probe at least five pounds……

Hmmm…. I don’t know I guess just scoop some corn out of the top of the bag and send it to her with a note that said we probed 5 pounds

Hmmm… Take some out of each barrel?

Or just scoop it out of one?

What is a mycotoxin?
Should we mark them all?

Does it really matter what this is?
Lets be safe and call it a fine powder.

Just send a little bit – they are testing it…..not eating it right?
Determination of Deoxynivalenol and Zearalenone in Single Kernels From a Highly Contaminated Corn Sample
Ryan J. Malone, Bruce R. Malone, Kraig K. Bond
 Trilogy Analytical Laboratory, Washington, MO, USA

Abstract

Corns, when exposed to cool growing conditions in the presence of Fusarium root rot, can be contaminated with deoxynivalenol and zearalenone mycotoxins. These mycotoxins currently are unregulated, with the exception of deoxynivalenol (DON) which is regulated at 1,200 ppm. A highly contaminated corn sample was analyzed to determine the distribution of deoxynivalenol and zearalenone in single kernels. The single kernels were separated into normal, slightly damaged, and highly damaged groups. The normal group showed no evidence of contamination, while the slightly damaged and highly damaged groups showed positive results for deoxynivalenol and zearalenone. The deoxynivalenol results were analyzed using a PLS model with temperature and humidity as independent variables. The results indicate that the deoxynivalenol contamination in the slightly damaged and highly damaged groups is significantly higher than in the normal group.

Kernel Examples

Procedure

Individual kernels from a high-contaminated corn sample were separated into three groups: normal, slightly damaged, and highly damaged kernels. The kernels were then analyzed using a PLS model with temperature and humidity as independent variables. The results indicate that the deoxynivalenol contamination in the slightly damaged and highly damaged groups is significantly higher than in the normal group.

Conclusions

- Deoxynivalenol and zearalenone contamination were detected in single kernels from a highly contaminated corn sample.
- A majority of the contaminated kernels were classified as slightly damaged.
- The deoxynivalenol contamination in the slightly damaged and highly damaged groups was significantly higher than in the normal group.
- The deoxynivalenol contamination in the slightly damaged and highly damaged groups was significantly higher than in the normal group.
- There was a correlation between the temperature and humidity conditions and the deoxynivalenol contamination in single kernels.
Kernel Examples

A26  DON  –  7.0 ppm
      ZONE  –  <0.1 ppm

B4   DON  –  263.2 ppm
      ZONE  –  82.8 ppm

C11  DON  –  659.0 ppm
      ZONE  –  30.9 ppm

C5   DON  –  699.3 ppm
      ZONE  –  0.8 ppm

C31  DON  –  559.0 ppm
      ZONE  –  10.4 ppm
The Food and Agriculture Organization of the United Nations has developed an interactive website to help users determine the best options for sampling and sample preparation specific to toxin/commodity combinations. This website allows the user to work through different scenarios to help determine the best options for individual situations with operational curves to determine risks.
Trilogy Analytical Laboratory

**Sampling Tools** – FAO Mycotoxin sampling Tool
Currently 26 commodity and toxin combinations

<table>
<thead>
<tr>
<th>Lab sample size</th>
<th># of aliquots</th>
</tr>
</thead>
<tbody>
<tr>
<td># of Lab Samples</td>
<td>Variation of Sampling Plan</td>
</tr>
<tr>
<td>Minimize Risk</td>
<td></td>
</tr>
</tbody>
</table>

Minimizing risk, ensuring safety and supporting any program in mycotoxin prevention and control. Developing such systems requires knowledge on the design of effective sampling plans. This is a complex task, and the heterogeneity of mycotoxin contamination in food commodities further increases the difficulty of estimating true contamination levels of affected lots. The classification of commodities into acceptable and unacceptable categories can only be made correctly if the mycotoxin concentration in the lot can be estimated with a high degree of accuracy and precision.

FAO is regularly contacted by national food safety agencies and by other development partners for guidance on sampling and interpretation of test results to determine and quantify mycotoxin contamination in a range of food commodities. In this context, as part of its technical assistance to developing countries in mycotoxin prevention and control, FAO has developed a Mycotoxin Sampling Tool (available at www.tstools.org) which provides support in analysing the performance of sampling plans, and determining the most appropriate plan to meet user’s defined objectives.

**WHAT CAN THE TOOL DO?**

The mycotoxin concentration of a food lot is usually estimated by measuring the mycotoxin concentration in a small representative sample following a defined protocol – i.e. the mycotoxin sampling plan. The performance of a sampling plan can be improved by modifying the parameters of the plan – the laboratory sample size, the number of laboratory samples of a given size, increasing test portion size, and/or increasing the number of aliquots quantified by the analytical method. The tool facilitates evaluation of the effect of varying sampling plan design parameters, on the performance of the sampling plan, and thus determining the most appropriate mycotoxin sampling plan to minimize risk of misclassifying lots according to needs and resources.

Sampling yes --- but don’t forget
Sample Preparation

We have hit this one … but don’t forget about extraction …… the solvent and how the sample is extracted – If you don’t get it from the sample to the liquid – you don’t detect it…. Period. Remember the Sampling Tools from FAO – it also provides the variability you can expect when you change parameters

There are trucks backed up – can I extract for less time?

The method says to extract 25 grams but I heard that you could extract 1 gram and just use less solvent – is that true?

How critical is grinding the sample?

Is it ok to “Hand Shake”?

I don’t have time to filter can I just use the solvent with the grain floating around in it?

How important is the extraction solvent ratio?
What goes into an accurate final result?

3.2 ppm DON

Sampling
Sample Prep
Purchasing Parameters
Quantification Limits
Sample Submittal
Confirmation of Results
Equipment Performance
Employee Education
Manufacturing Process

Commodity Selection
Testing frequency
Lot Size
Analytical Variability
Extraction Efficiency
Extraction Size
Method suitability
Mesh size of samples

Outside Lab Competence
Storage Conditions
Weather Conditions

Trilogy Analytical Laboratory
This is the Ultimate Goal – Getting the Correct Number

Technician Training

analytical excellence in food & feed safety
Abstract

Aflatoxin contamination in the 2012 US corn crop was widespread. This resulted in an increase of the overall amount of aflatoxin testing performed on corn and corn products. Sample preparation of products being tested for aflatoxin is a critical part of the total analytical process. It is well documented that sampling contributes a large portion of the total overall analytical variability. Differences in sample grind size as well as the amount of sample extracted can also contribute to the overall analytical variability. An evaluation was conducted to compare the extraction of corn naturally contaminated with aflatoxin utilizing different sample grinds and different sample extraction weights. The naturally contaminated corn was ground to various mesh sizes, homogenized and various sample sizes were extracted. The extractions were performed using acetone/hexane/h2o (8:4:16). The extracts were then analyzed by HPLC using a modification of ACID method 941.3. Data presented shows the effect grind size and sample extraction size has on result variability of aflatoxin.

Procedure

Ten pounds of whole corn known to be naturally contaminated with aflatoxin was selected for this evaluation and ground to four different mesh size and sampled as described below. Four different sizes (25.0, 10.0, 5.0 and 1.0 g) were weighed in replicates of ten from each of these samples.

1. The entire ten pound sample was ground through a bun mill with settings to ensure approximately 60% passed through a 19 mesh sieve. After grinding, 100 grams were skived to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

2. The remaining sample from above was ground through a bun mill so that approximately 60% percent passed through a 28 mesh sieve. After grinding, 100 grams were skived as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

3. The remaining sample from above was ground through a bun mill with settings to ensure approximately 80% percent passed through a 28 mesh sieve. After grinding, 100 grams were skived as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

4. The remaining sample from above was ground through a Flitch Mill fitted with a 30 mesh screen so that 100% percent passed through a 30 mesh sieve. After grinding, 100 grams were skived as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

All samples were then extracted with Acetone/hex/h2o (8:4:16) and analyzed for aflatoxin with ACID method 941.3B using a TOSA 6060A for post data column chromatination.

Results

Total Aflatoxin Results Compilation

Results Range

-10 mesh
-20 mesh
-30 mesh

<table>
<thead>
<tr>
<th>Sample Size (g)</th>
<th>Results Range</th>
<th>Results Range</th>
<th>Results Range</th>
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<tr>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Mean</strong></td>
<td><strong>S.E.</strong></td>
<td><strong>Range</strong></td>
<td><strong>Range</strong></td>
</tr>
<tr>
<td><strong>g</strong></td>
<td><strong>µg/g</strong></td>
<td><strong>µg/g</strong></td>
<td><strong>µg/g</strong></td>
</tr>
<tr>
<td>25</td>
<td>34.7 ± 1.5</td>
<td>22.5 ± 1.5</td>
<td>11.5 ± 1.5</td>
</tr>
<tr>
<td>10</td>
<td>38.2 ± 1.5</td>
<td>23.7 ± 1.5</td>
<td>12.5 ± 1.5</td>
</tr>
<tr>
<td>5</td>
<td>39.5 ± 1.5</td>
<td>25.7 ± 1.5</td>
<td>15.5 ± 1.5</td>
</tr>
<tr>
<td>1</td>
<td>43.5 ± 1.5</td>
<td>27.9 ± 1.5</td>
<td>16.5 ± 1.5</td>
</tr>
</tbody>
</table>

| **Range**        | **µg/g**     | **µg/g**     | **µg/g**     |
| **g**            | **µg/g**     | **µg/g**     | **µg/g**     |
| 25              | 22.5 ± 1.5   | 22.5 ± 1.5   | 22.5 ± 1.5   |
| 10              | 23.7 ± 1.5   | 23.7 ± 1.5   | 23.7 ± 1.5   |
| 5               | 25.7 ± 1.5   | 25.7 ± 1.5   | 25.7 ± 1.5   |
| 1               | 27.9 ± 1.5   | 27.9 ± 1.5   | 27.9 ± 1.5   |

**Conclusions**

Historically, much emphasis has been placed on the effect sampling has on aflatoxin testing and the large amount of variability contributed by sampling procedures. This poster demonstrates the importance of sample preparation in aflatoxin analysis and the variability that can also be incurred with different sample preparation parameters.

- This evaluation demonstrates the finer a sample is ground the result variability decreases, however, appropriate sample mesh size for extraction must be maintained or variability increases.
- Larger sample size improved variability, however 10 mesh and 20 mesh (10%) did not produce results with less than a 1% CV on any sample extraction size.
- This evaluation also indicates that a one gram sample size, regard less of grind size should never be utilized.
- While five grams is not the preferred sample extraction weight, the variability at thirty mesh and twenty mesh (15%) appears to be consistent with a CV of 13.0% to 14.4%. It is a 10 gram sample size is utilized, the sample can be finely ground in order to provide reasonable results.
- This research confirms that a twenty-five gram sample at either a twenty mesh (93%) or a thirty mesh (98%) or any grain sample of thirty mesh (100%) all have less than a 1% CV. One of these three testing parameters should be utilized for aflatoxin testing.
Ten pounds of whole corn known to be naturally contaminated with Aflatoxin was selected for this evaluation and ground to four different mesh sizes and sampled as described below. Four different sizes (25.0 g, 10.0 g, 5.0 g and 1.0 g) were weighed in replicates of ten from each of these samples.

1. The entire ten pound sample was ground through a burr mill with settings to ensure approximately 50% passed through a 10 mesh sieve. 100 grams were sieved to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

2. The remaining sample from above was ground through a burr mill so that approximately 50% percent passed through a 20 mesh sieve. 100 grams were sieved as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

3. The remaining sample from above was ground through a burr mill with settings to ensure approximately 95% percent passed through a 20 mesh sieve. 100 grams were sieved as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

4. The remaining sample from above was ground through a Retsch Mill fitted with a 30 mesh screen so that 100% percent passed through a 30 mesh sieve. After grinding, 100 grams were sieved as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

All samples were then extracted with Acetonitrile/water (84/16) and analyzed for aflatoxin with AOAC method 994.08 using a KOBRA cell for post column bromination.
## Total Aflatoxin Results Compilation

<table>
<thead>
<tr>
<th>Mesh Size</th>
<th>Sample Size</th>
<th>Mean (ppb) *</th>
<th>STD DEV (ppb)</th>
<th>% CV</th>
<th>Low</th>
<th>Range (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td><strong>Total Aflatoxin = Sum of B1, B2, G1, G2</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 mesh</td>
<td>25 grams</td>
<td>45.5</td>
<td>41.1</td>
<td>90.4%</td>
<td>9.9</td>
<td>141.6</td>
</tr>
<tr>
<td>52.8% pass through</td>
<td>10 grams</td>
<td>40.2</td>
<td>23.7</td>
<td>58.9%</td>
<td>16.3</td>
<td>83.1</td>
</tr>
<tr>
<td></td>
<td>5 grams</td>
<td>128.7</td>
<td>236.6</td>
<td>183.9%</td>
<td>4.7</td>
<td>763.3</td>
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<tr>
<td></td>
<td>1 gram</td>
<td>61.0</td>
<td>112.7</td>
<td>184.9%</td>
<td>6.6</td>
<td></td>
</tr>
<tr>
<td>10 mesh</td>
<td>25 grams</td>
<td>34.8</td>
<td>20.9</td>
<td>60.1%</td>
<td>12.3</td>
<td>65.8</td>
</tr>
<tr>
<td>51.3% pass through</td>
<td>10 grams</td>
<td>30.2</td>
<td>14.0</td>
<td>46.5%</td>
<td>14.7</td>
<td>52.2</td>
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<tr>
<td></td>
<td>5 grams</td>
<td>43.7</td>
<td>45.8</td>
<td>104.8%</td>
<td>15.0</td>
<td>171.0</td>
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<tr>
<td></td>
<td>1 gram</td>
<td>36.5</td>
<td>41.6</td>
<td>114.0%</td>
<td>5.1</td>
<td>158.8</td>
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<tr>
<td>20 mesh</td>
<td>25 grams</td>
<td>35.5</td>
<td>3.5</td>
<td>9.8%</td>
<td>30.7</td>
<td>41.7</td>
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<tr>
<td>97.1% pass through</td>
<td>10 grams</td>
<td>33.2</td>
<td>5.3</td>
<td>15.9%</td>
<td>28.1</td>
<td>42.1</td>
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<tr>
<td></td>
<td>5 grams</td>
<td>30.6</td>
<td>4.2</td>
<td>13.6%</td>
<td>21.0</td>
<td>36.0</td>
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<tr>
<td></td>
<td>1 gram</td>
<td>34.4</td>
<td>12.1</td>
<td>35.1%</td>
<td>20.7</td>
<td>64.3</td>
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<td>30 mesh</td>
<td>25 grams</td>
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<td>1.4</td>
<td>4.9%</td>
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<td>31.3</td>
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<tr>
<td>100% pass through</td>
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<td>32.6</td>
<td>3.0</td>
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<tr>
<td></td>
<td>5 grams</td>
<td>28.8</td>
<td>4.2</td>
<td>14.4%</td>
<td>27.0</td>
<td>34.3</td>
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<tr>
<td></td>
<td>1 gram</td>
<td>30.1</td>
<td>10.7</td>
<td>35.6%</td>
<td>15.9</td>
<td>46.1</td>
</tr>
</tbody>
</table>

* All of the listed mean values represent 10 individual extracts at each mesh/sample size combination. The 10 individual results were averaged and standard deviation and %cv calculated for each sample set. The ppb range simply notes the lowest and highest result observed for each sample set.
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Aflatoxin Study

This graphic shows work that Trilogy performed and shows the analytical effect differences in grind size – and sample extraction size have on the final result.

Finer grind and larger sample size produce much tighter and more accurate results.

- Different color Spots are different sample size
- Bars are fineness of grind
• This evaluation demonstrates the finer a sample is ground the result variability decreases, however appropriable sample mesh size for extraction must be maintained or variability increases.

• Larger sample size improved variability, however 10 mesh and 20 mesh (50%) did not produce results with less than a 46% cv at any sample extraction size.

• This evaluation also indicates that a one gram sample size, regardless of grind size should never be utilized.

• While five grams is not the preferred sample extraction weight, the variability at thirty mesh and twenty mesh (95%) appears to be consistent with a CV of 13.58% to 14.44%. If a 5.0 gram sample size is utilized, the sample must be finely ground in order to provide reasonable results.

• This research confirms that a twenty five-gram sample at either a twenty mesh (95%) or a thirty mesh (100%) or a ten gram sample at thirty mesh (100%) all have less than a 10% cv. One of these three testing parameters should be utilized for aflatoxin testing.
Ten pounds of whole corn known to be naturally contaminated with Fumonisins was selected for this evaluation and ground to four different mesh size and sampled as described below. Four different sizes (25.0 g, 10.0 g, 1.0 g and 0.5 g) were weighed in replicates of ten from each of these samples. 1. The entire ten pound sample was ground through a burr mill with settings to ensure approximately 50% passed through a 10 mesh sieve. After grinding, 100 gms were saved as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize. 2. The remaining sample from above was ground through a burr mill to that approximately 50% passed through a 20 mesh sieve. After grinding, 100 gms were saved as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize. 3. The remaining sample from above was ground through a burr mill with settings to ensure approximately 50% passed through a 10 mesh size. After grinding, 100 gms were saved as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize. 4. The remaining sample from above was ground through a stainless steel 30 mesh (100%) all have similar variability at this contamination level. Larger sample size improved variability, however 10 mesh and three sample sizes (1 gram, 5 grams and 10 grams) at the 20 mesh (95%) did not produce results with less than a 10% CV. This evaluation also indicates that a one gram sample size, regardless of grind size produces large increases in result variability. While five grams is not the preferred sample extraction weight, the variability at thirty mesh and twenty mesh is comparable to be consistent with a CV of less than approximately 7%. If a 5.0 gram sample size is utilized, the sample must be finely ground and mixed in order to produce reasonable results. This research confirms that twenty five-gram samples and ten gram samples at either a twenty mesh (95%) or a thirty mesh (100%) all have similar variability at this contamination level.
Ten pounds of whole corn known to be naturally contaminated with Fumonisins was selected for this evaluation and ground to four different mesh size and sampled as described below. Four different sizes (25.0 g, 10.0 g, 5.0 g and 1.0 g) were weighed in replicates of ten from each of these samples.

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3. The remaining sample from above was ground through a burr mill with settings to ensure approximately 95% passed through a 20 mesh sieve. After grinding, 100 grams were sieved as above to determine exact mesh size composition of the sample. The remaining sample was then mixed to homogenize.

4. The remaining sample from above was ground through a Retsch Mill fitted with a 30 mesh screen so that 100% passed through a 30 mesh sieve. After grinding, 100 grams were sieved as above to determine exact mesh size composition of the sample.

The remaining sample was then mixed to homogenize. All samples were then extracted with Methanol/Water 3/1 and analyzed by AOAC Method 995.15
# Fumonisin Study

<table>
<thead>
<tr>
<th>Mesh Size</th>
<th>Sample Size</th>
<th>Mean (ppm)</th>
<th>STD DEV (ppm)</th>
<th>% CV</th>
<th>Range (ppb)</th>
</tr>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low</td>
</tr>
<tr>
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<td>1.2</td>
<td>84.0</td>
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<td>1.2</td>
<td>102.7</td>
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<td>1.7</td>
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<tr>
<td></td>
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<td>2.1</td>
<td>0.6</td>
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<td>1 gram</td>
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<td>0.2</td>
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<td>20 mesh</td>
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<td>0.1</td>
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<td>0.2</td>
<td>10.4</td>
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<tr>
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<td>2.1</td>
<td>0.1</td>
<td>4.8</td>
<td>2.0</td>
</tr>
</tbody>
</table>

* Total Fumonisin = Sum of B1, B2, B3

- All of the listed mean values represent 10 individual extracts at each mesh/sample size combination. The 10 individual results were averaged and standard deviation and %CV calculated for each sample set. The ppm range simply notes the lowest and highest result observed for each sample set.
This graphic shows work that Trilogy performed and shows the analytical effect differences in grind size – and sample extraction size have on the final result.

Finer grind and larger sample size produce much tighter and more accurate results.

- Different color Spots are different sample size
- Bars are fineness of grind
This evaluation demonstrates the finer a sample is ground the result variability decreases, however appropriate total sample size (grams) for extraction must be maintained or variability increases.

Larger sample size improved variability, however 10 mesh and three sample sizes (1 gram, 5 grams and 10 grams) at the 20 mesh (50%) did not produce results with less than a 10% CV.

This evaluation also indicates that a one gram sample size, regardless of grind size produces large increases in result variability.

While five grams is not the preferred sample extraction weight, the variability at thirty mesh and twenty mesh (95%) appears to be consistent with a CV of less than approximately 7%. If a 5.0 gram sample size is utilized, the sample must be finely ground and mixed in order to provide reasonable results.

This research confirms that twenty five-gram samples and ten gram samples at either a twenty mesh (95%) or a thirty mesh (100%) all have similar variability at this contamination level.
Extractions

- 84/16 Acetonitrile/Water
- 60/40 Acetonitrile/Water
- 84/16/1 Acetonitrile/Water/Formic Acid
- 80/20 Acetonitrile/Water
- 80/20 Methanol/Water
- 3/1 Methanol/Water
- 85/15 Methanol/Acetonitrile (QuEChERS)
- 90/10 Acetonitrile/Water
- 79/20/1 Acetonitrile/Water/Acetic Acid followed by 20/79/1 Acetonitrile/Water/Acetic Acid
Now that I know my “recommended grind and extraction size” What should I extract with??

Know what extraction solvent works best for your method and your mycotoxin

Aflatoxin Extraction Comparison

Deoxynivlenol Extraction Comparison
Trilogy Analytical Laboratory
Extraction Solutions…know what works

**Fumonisin Extraction Comparison**

- Methanol/water
- Concentration of Naturally Contaminated Sample
- Extraction Solution Ratio (Acetonitrile/Water)

**T2 Extraction Comparison**

- Will my method work efficiently with another extraction?

Do I have to use the “official method extraction”
What Do We Know So Far...

- Education...use the tools available to determine what’s the best practices for mycotoxin evaluation
- Sample Size – proper sampling and sample size will assist in determining the contamination concentration of the whole sample
- Grind Size
  - The finer a sample is ground the result variability decreases, however appropriate sample mesh size for extraction must be maintained or variability increases.
  - Larger sample size improved variability
- Analytical Sample Size
  - a one gram sample size, regardless of grind size should never be utilized
  - If a 5.0 gram sample size is utilized, the sample must be finely ground and mixed in order to provide reasonable results.
  - This research confirms that twenty five-gram samples and ten gram samples at either a twenty mesh (95%) or a thirty mesh (100%) all have similar variability at this contamination level

- Mycotoxin Extraction Solvents – use the “best fit” for your method
Thank You

Questions?