Feature: Global Milling

Advanced cleaning solutions critical to reduction of mycotoxin levels in cereal grains

In the past few years grain processors from across the world have intensified their efforts to ensure safe food and feed despite a growing number of emerging threats. Due to these threats product specifications are becoming increasingly complex. Matthias Graeber, mycotoxin expert within Bühler’s Corporate Technology Group, discusses how advanced separation and optical sorting solutions can be used to manage the risk of mycotoxins and other hazardous contaminants.

Among the growing number of safety concerns in grains are pathogens such as salmonella, non-declared allergens, such as gluten-containing foreign kernels in gluten-free produce, foreign bodies, and of increasing importance, the widespread presence of mould fungi and their hazardous metabolites referred to as mycotoxins. Aflatoxin, deoxynivalenol (DON), Zearalenone (ZEA) and ergot alkaloids are the mycotoxins creating the most concern, as they are common in grains such as wheat, maize, rye, barley and spelt. With some mycotoxins such as the highly-toxic Aflatoxin, the vast majority of grains are not affected, but just a few highly contaminated kernels could make an entire lot unsafe for further use.

One example of an unsafe situation caused by aflatoxins, was in 2012/2013, when South-East European countries were facing a crisis. Contaminated maize was consumed by dairy cows, leading to cases of unsafe levels of the highly toxic aflatoxin M1 in milk intended for human consumption. There has also been a re-emergence of ergot alkaloids in rye in Central Europe, causing the relevant authorities to revise safety assessments and, as a result, ultra-low commercial specifications have been imposed by some companies. Such examples highlight the need to support grain processors in their ongoing efforts to ensure safe products. Through its Food Safety Initiative, Bühler continues developing and offering a comprehensive set of market-specific solutions.
Early intervention - best practice for preventing and eliminating food hazards

In order to control the hazards, grain processors must first follow the guidelines of good agricultural and post-harvest practice, to reduce the risk of hazardous contamination in cereal grains. However, as extreme weather conditions may cause plant stress, making the crop more susceptible to fungal infestations, problems may still occur, despite following best practice guidelines.

In light of these ongoing problems, grain processors require solutions that ensure grain lots comply with commercial specifications and legal maximum levels of toxins. Grain processors also need to make sure any initial contamination does not spread any further, by removing the small percentages of hazardous grains, as early as possible in the value chain.

In the case of maize, for instance, in some regions the crop has been severely hit in successive years by different mycotoxins. In response processors have implemented advanced grain cleaning processes to target the affected grains, not only in mills but upstream in the chain at both collection point and warehouse levels.

Such advanced grain cleaning complements well-established, pre-cleaning processes at a collection point. for a good example of this is Bühler’s TAS grain cleaner, which is available for large capacities of up to 250 tonnes per hour.

Removing trace levels of toxins, consistently

It is well known that modern grain cleaning technologies can significantly reduce the concentrations of mycotoxins in cereal grains. However, one needs to keep in mind that removing affected grains from a lot can also negatively impact the processor’s yield. It is therefore critical to tailor grain cleaning processes in such a way that mycotoxin levels are reduced effectively and consistently, despite the natural variability of the raw product. This process must also be efficient, with minimal loss of good, unaffected product. This is particularly important as there is no technology available that can directly detect mycotoxins, non-destructively, on cereal grains – certainly not at a product flow of many tons per hour.

The actual measurement of mycotoxins at the relevant levels – ranging from a few parts per billion (ppb) for aflatoxins to parts per million (ppm) for deoxynivalenol – requires processors to remove a representative sample from the product and then analyse it, using commercially available antibody-based test kits or high performance liquid chromatography (HPLC) laboratory analysis. Therefore,
instead of actually detecting mycotoxins, modern grain cleaning technologies target the properties that indicate the presence of a fungal contamination and thus the potential of a mycotoxin contamination.

**Processing expertise building on engineering excellence makes the difference**

Following Bühler's dedication to provide innovations for a better world, they have partnered with grain processors and world leading researchers in mycotoxin management, such as the Institute of Sciences of Food Production (ISPA) in Italy, to develop solutions for the cleaning of mycotoxin from cereal grains and to provide conclusive data as reference case studies. The results from these case studies have enabled Bühler experts to define standard flow diagrams, incorporating elements for mechanical separation and optical sorting of grains. For example, size separation as performed by Bühler's Grain Plus LAGA, removes broken kernels from the lot, as these tend to have a higher concentration of mycotoxins.

It has also been found that very light product and dust from affected lots typically contain higher levels of mycotoxins, which can be removed through integrated or separate air aspiration systems. A further separation of lower-density grains, using Bühler’s Concentrator MTCB, further decreases the mycotoxin concentration. Finally, an optical sorter such as Bühler's SORTEX A MultiVision™ detects even the most subtle of colour defects and, using InGaAs technologies, can distinguish anomalies in the non-visible infrared reflectance of the cereal grains. This part of the electromagnetic spectrum can access information about chemical changes in the grains and has proven to be highly effective in identifying mycotoxin-contaminated grains.

It is understood that the larger the mycotoxin concentration in the removed product, the more efficient the cleaning process. As a result, the reduction of aflatoxin levels can then be achieved with less good product removed. Figure 1 highlights the results of an actual case study, carried out on an aflatoxin-contaminated lot of maize in an Italian cleaning facility, running at a throughput of 20 tons per hour.

The results reveal the relative concentration of total aflatoxins in the fractions removed by size separation, aspiration channel, density separation and optical sorting, respectively. The product rejected by the SORTEX A optical sorter, for instance, contained an aflatoxin level of more than 1100 percent of the levels detected in the input material. Such high levels in the removed fractions are a direct result of utilising expert knowledge on the product properties that indicate fungal contaminations, together with world-class engineered optical sorting equipment. This ensures an optimised high capacity product flow, robust high-speed detection of the defective product and accurate ejection.
Advanced cleaning can also reduce other hazards

In addition, SORTEX optical sorters reliably remove foreign kernels and foreign materials which represent a further food safety concern, as they can cause injury if eaten. It is essential to prevent these serious issues, to avoid putting people’s health in danger as well as risking costly, commercially damaging product recalls and adverse impact on business relationships. The SORTEX portfolio offers a wide range of customisable product options, including advanced proprietary vision and feed systems, allowing processors to meet their exact sorting requirements. These may include, in addition to controlling mycotoxin levels, the removal of discoloured/diseased kernels or the separation of wheat from oats to ensure a gluten free product, or the separation of GMO soy and maize from wheat.

Ensuring profitability for grain processors

Bühler’s cleaning solutions for fungal contaminations are available for a wide range of cereal grains, such as wheat, maize, barley and rye, tackling a variety of hazardous fungal contaminations including aflatoxins, DON, ZEA, and ergot alkaloids. Building on outstanding engineering expertise and extensive experience in the reduction of fungal contaminations, in almost any food or feed material, Bühler experts are well placed to identify the solution that is the best match for grain processors needs, ensuring safe food and feed, while maintaining business-critical profitable yields.

<table>
<thead>
<tr>
<th>Process Stage</th>
<th>Relative Aflatoxin B1 concentration (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input maize</td>
<td>100</td>
</tr>
<tr>
<td>Size separation: Removed fraction</td>
<td>419</td>
</tr>
<tr>
<td>Aspiration 1: Removed fraction</td>
<td>632</td>
</tr>
<tr>
<td>Aspiration 2: Removed fraction</td>
<td>1142</td>
</tr>
<tr>
<td>Density separation: Removed fraction</td>
<td>917</td>
</tr>
<tr>
<td>SORTEX optical sorting: Rejected fraction</td>
<td>3136</td>
</tr>
<tr>
<td>Cleaned maize</td>
<td>16</td>
</tr>
</tbody>
</table>

Figure 1: Aflatoxin concentration of input and cleaned maize, as well as of the fractions removed by the sequential processing steps. The aflatoxin concentration of the input maize has been set to a value of 100 percent. The reduction performance is case specific and may vary for different types of contamination. The sampling followed EU Comission Regulation No 401/2006. Aflatoxin analysis was carried out using HPLC.
About Bühler:
Every day, billions of people come into contact with Bühler technologies to cover their basic needs for foods, mobility, or communication. With our industrial-scale process technologies and solutions, we contribute significantly to feeding the world’s population, setting the focus on food security and food safety. Bühler flour mills process around 65% of the wheat harvested worldwide into flour. Its contribution to processing rice and producing pasta, chocolate, or breakfast cereals is similarly important. Moreover, Bühler is a leading solution provider of die casting, wet grinding, and surface coating technologies, with an emphasis on automotive, optics, electronics, printing & packaging inks, and glass applications. The solutions provided for these industries are distinguished by high energy efficiency and sustainable mobility. As a leading technology group, Bühler invests up to 5% of its sales revenue in research and development. Bühler is proud of its Swiss roots, with 10,600 employees in some 140 countries generating sales of CHF 2.3 billion. The family-owned company Bühler is particularly committed to sustainability.

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