The evolution of grain & oilseed analysis methods

How new technology is ensuring the highest standards of safety and quality at every stage of the grain journey

by Wes Shadow, Global Market Manager for Grain & Processed Food, PerkinElmer, Inc. Applied and Food segment

I've been involved in the grain industry for over 30 years. This started when I joined Perten Instruments, working in and managing the applications department. I focused on NIR calibration development and supporting Falling Number testing. During that time, NIR has really grown to be the go-to technique for rapid analysis of food, grain, flour, and feed analysis.

In 2014, when Perten Instruments became a part of PerkinElmer, we were able to combine PerkinElmer's long-standing analytical and methodology development expertise with Perten's food market expertise to now offer the world's most comprehensive set of food analysis solutions across safety and quality testing.

Analysing grain across the workflow

Increasingly strong pressures continue to create challenges such as ever-changing regulations, shifting markets, global and supply chain forces and climate change.

All of these drivers, however, are secondary to safety.

Take mycotoxin testing for example. That can be heavily affected by all of these forces, especially by global supply issues and extreme weather conditions driven by climate change – this includes both floods and droughts. Globally, it's estimated that around 25 percent of our global food crop has been contaminated by mycotoxins above regulatory limit levels.

To try and control these toxic residues, the US Food and Drug Administration (FDA) has set action levels of 20 parts per billion (ppb) for mycotoxins in several types of grain. EU regulatory limits go as low as 2ppb. As such, contaminants must be detected with accurate, sensitive and innovative technologies to prevent issues from cropping up; from the grain silo, right through to the milling and ingredient supply chain.

Another challenge the industry is facing – and which affects activities such as mycotoxin testing – is the necessity to use operations people – truck drivers, plant operators etc – to perform sensitive tests. When you have to consistently monitor these contaminants at such low levels, it can be difficult, especially without proper training and instrumentation. Rapid test strips utilising hand-held automated readers have emerged are helping non-scientifically trained staff to carry out crucial first-line tests.

Broader and deeper confirmatory tests can then be done with more advanced technologies, such as liquid chromatography and LC/MSMS, to provide full workflow support and ultimate detection and confirmation.

Grains are also taking on a new challenge – plant-based – animal-free foods. Grains, pulses, legumes, and other plant-based protein and starch sources are being transformed into meat analogues or being used as input materials for cultured meat products.

New processes for isolates, fractions, and extractions are happening at a very rapid pace. Add in the upcycling of former 'waste' products, and these new uses are creating new ingredient performance requirements and thus new types of testing and evaluation.

Finally, if you back up beyond individual workflows to the entire grain supply chain, a large challenge is ensuring that different players in the value chain get the testing and analysis data they need and want at every stage of the grain journey.

Although there is some overlap in the data needs of farmers, traders, processors and ingredient providers they may need different slices of information or use it in different ways. Understanding the nuances of those differences – which can also be regional – is very important to ensure our grain testing solutions actually meet the needs of both the industry and individual users along the way.

As these challenges converge, intuitive rapid testing, end-to-end high throughput workflows, and automated testing solutions are becoming increasingly vital to support supply chain integrity and grain valuation.

Additionally, we're seeing many food processors and their contract labs strategically partnering with experienced industry instrument and solutions providers to ensure they have the right tools for their needs.

In turn, these partners can also support the implementation of ISO-accredited methods which help meet the tightest industry regulations.

How consumer trends are impacting grain analysis

As the global population grows, grains continue to see a growth in demand. At the same time, consumer attitudes towards food, health, and sustainability are ever-evolving to include more plant-based, animal-free, gluten-free, and clean label foods, as consumers start making more eco-conscious and health-driven choices. These converging trends put further pressure on grain analysis.

With consumers increasing their demands for more sustainable and cleaner grain-based foods, sustainability in farming and agriculture is also altering grain supply chains. As farms and processors adopt greener methods to promote sustainability, several challenges are arising.

Greener regulatory approaches to pesticide use and its resulting residues can impact yields and overall grain quality. This will have a knock-on effect throughout the supply chain, driving demand for portable, versatile, and accurate testing tools to ensure traceability in the supply chain and provide stakeholders with full confidence in their grains, ingredients, processes, and outputs at every stage.

Furthermore, the demand for plant-based/animal-free foods is rising as consumers look to purchase products that meet their views on sustainability and health – for example, the rise of consumers adding consumption of oat, rice, and the myriad of other milk alternatives.

As such, the entire supply chain from farmers to processors is proactively implementing novel processes that adapt to changing customer tastes. As an example, we're seeing that more food processors are leveraging versatile rheological testing technologies to gain better insight into the performance of both grains and grain products – including upcycled materials - enabling innovative product development.

These technologies provide a solution to meet the dual challenge of consumer demands for new products and expectations for safe, high-quality, texture, taste, and functionality.

Changing testing technologies

There are three primary categories of analysis at work– the aforementioned mycotoxin testing, performance testing, and process monitoring.

The demand for more specialised grains - including 'new' old grains, hybrids, fractions, and isolates - has led to devices that analyse performance being more important than ever. These devices can effectively monitor performance under varying temperature, shear, and time parameters. Consumer trends for new products have increased the need for rheology-based testing.

Some of the most important technological advances include innovative rheology-based performance analysis that has become increasingly important to provide accurate and fast analysis for new product development, reformulation, ingredient selection, and process optimisation. These technologies are vital due to develop the next generation of plant-based/animal-free foods. This technology can be used to give scientists insights into how

to better improve ingredients to satisfy consumer demand.

At the same time, with the razor-thin margins of grain trade and processing, process monitoring and resulting process control are also critical. In-line and on-line Near-infrared (NIR) process monitoring is finally seeing widespread adoption. This is happening for several reasons.

First, newer technologies are proving robust enough to be relied upon for extended periods. Secondly chemometrics capabilities have steadily improved, and finally, processors themselves have begun to realise the value of real-time data in making processing adjustments and mid-course decisions.

The implementation of process analysers, like in-line, also helps reduce waste in all its forms – labour, ingredient cost, energy and materials which obviously impacts margins in a positive way as well, so this is a strong reason to adopt the technology.

The evolution of grain and oilseed analysis methods

The grain industry as a whole, deals in bulk commodities and thus requires tests that are fast enough to keep up with material exchange and processing. They must quickly and accurately determine material value to enable proper and fair valuation.

Therefore, they have to be used by operational/non-scientific staff as well or be automated. Simply put, analysis techniques continue to become faster, simpler, more robust, and more accurate.

More specifically, changing grain and plant sources – necessitated by consumers, sustainability, and climate change demands – will bring about new testing requirements.

Whilst the industry will still be dominated by wheat, rice, corn, soy, pulses, legumes, 'local' grains, and other plant-based materials – cassava, jack fruit, etc – will see growth. These sources will be incorporated into existing infrastructure but will also require expansion and development varying by geography. Clean-label foods and a shift toward more natural ingredients are also bound to require more extensive analysis and testing methods, as processors prepare to deal with novel food matrices mentioned above. This also calls for more and different testing requirements.

Lastly, on-going review of safety concerns spurred by new materials, climate change, and geographically sourced materials will continue to increase demand for high-throughput, high-quality testing by contract labs for the top safety concerns – pathogens and mycotoxins.

Automation will be the main component here and continue to ramp up to meet the demand for less hands-on workflows and provide faster, more accurate testing at lower detection limits.

This will also increase throughput by providing labs with solutions that can test for multiple parameters in a single sample run, helping reduce costs while improving result turn-around times.

About the author:

Wes Shadow is the Global Market Manager for Grain & Processed Food as part of the Food segment at PerkinElmer, Inc. After graduating from Westminster College in Utah, he has forged a 30-year career in the scientific testing and research industry, serving the global food and grain market.

In his current role, he works to showcase PerkinElmer's "best-in-class" portfolio of grain & food analysis and testing solutions and services to help assure ingredient-to-product quality and safety for producers and consumers.