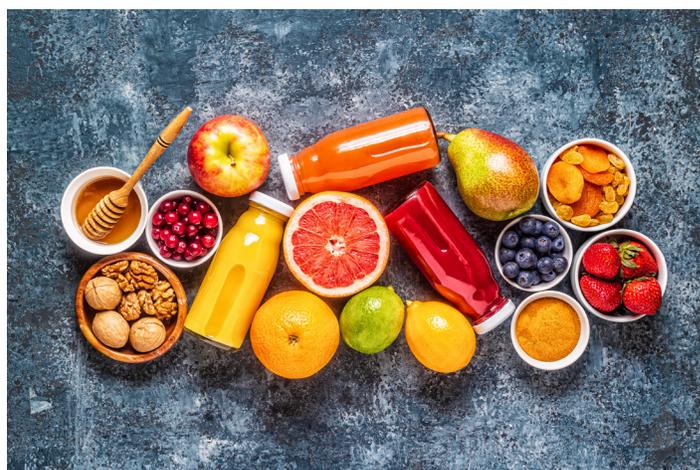


Combine selectivity and sensitivity for rapid multi-parameter sugar analysis with automated discrete analyzers

Sugar analysis is a critical quality assurance and control (QA/QC) parameter in many manufacturing industries, from the production of wine and beer to the creation of vaccines and biofuels. Whenever sugar is an ingredient or product, analysis is key to assessing process progression and product quality. However, since sugars are often part of a complex matrix and are closely connected to other quality parameters, analysis is often challenging.

For many years, QA/QC laboratories have been relying on multiple techniques to elucidate results, determining sugar in a variety of matrices with complex technology, such as titration, high-performance liquid chromatography (HPLC) and ion chromatography (IC). These techniques rely on highly skilled operators running complicated, error-prone and time-consuming workflows and, in fast-paced manufacturing environments and contract testing laboratories, sugar analysis places huge pressures on overworked QA/QC teams. Since delayed results mean delayed decision-making, time-consuming techniques can be damaging to industries that rely on continuous monitoring to deliver safe products that meet brand standards.



This executive summary provides an overview of a recent Thermo Fisher Scientific webinar presented by Dr. Hari Narayanan on [Rapid Sugar Analysis by Automated Discrete Analyzer](#). During the session, Dr. Narayanan demonstrated how this automated method can achieve rapid sugar analysis through enzymatic methods with photometric detection. While delivering selectivity and sensitivity, the technique delivers results in a fraction of the time, versus the more traditional methods. With automated workflows, higher throughputs and a reduced skill requirement, laboratories can now produce up to 350 sugar assays per hour, a four-fold increase on the number offered by traditional methods.

Keeping it short and sweet—the importance of measuring sugar

Sugar analysis is used to assess raw material quality, monitor reactions, standardize products and detect adulteration in a variety of industrial processes; it includes detection and quantification of reducing sugars, such as glucose, fructose and galactose, as well as non-reducing sucrose (Figure 1).

In biopharmaceutical production, residual sugar analysis is a measure of fermentation progression, with the rate of sugar consumption directly related to the growth of a cell line. In the pharmaceutical industry, sugar is used as a carrier, coating agent and sweetener, as well as a gradient for dialysis solutions. Moving to food and beverage manufacturing, sugar monitoring is essential at every stage

of winemaking. From the initial must and juice, through to fermentation and bottling, residual sugars impact the taste and stability of the end product. In beer and spirit fermentation processes, sugar concentration signals enzymatic activity and the breakdown of starch to sugars. Tight control of these processes is needed to standardize alcohol concentration and taste. Similarly, in biofuel production, enzymatic breakdown of crop starches needs to be carefully monitored to ensure controlled fermentation and standardized alcohol concentrations.

As a quality indicator, rapid sugar analysis is an essential tool for fast and informed decision making, decisions which can often be directly linked to safety, costs and brand equity.

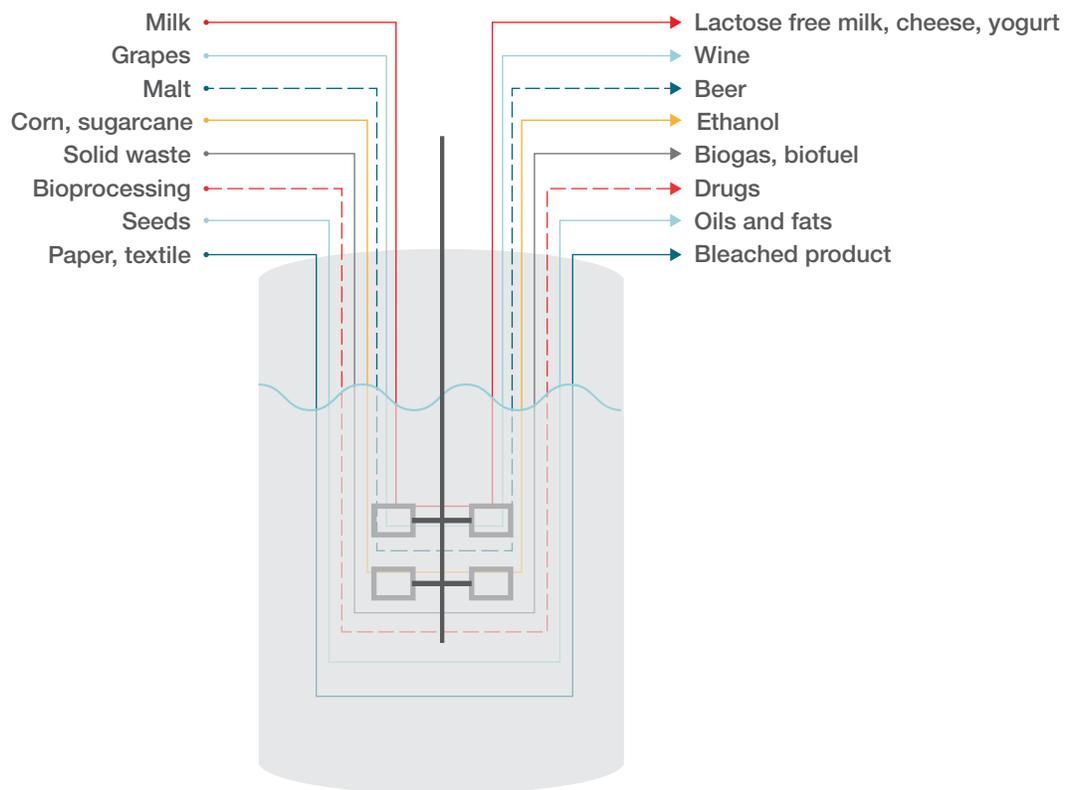


Figure 1. Rapid sugar analysis measures a variety of fermentation metrics that lead to the production of many valuable products.

Traditional methods can't meet the triple challenge of speed, sensitivity and selectivity

The elucidation and measurement of sugars, along with a variety of other quality parameters, naturally has its challenges. Complex matrices mean that lengthy pre-sample cleanups are often needed to ensure data integrity. With huge concentration ranges, depending on the production stage, sensitivity is a key requirement and techniques need to be just as effective at the grams-per-liter level as they are at the milligram level. While meeting all of these challenges and more, QA/QC laboratories are expected to deliver rapid results to ensure swift decision-making in fast-paced manufacturing environments.

Laboratories have commonly relied on a variety of techniques to deliver sugar analysis, often combining many technologies to achieve multi-parameter results at the required sensitivity. Traditional methods such as titration and gravimetry are still popular in the pharmaceutical industry; although HPLC with refractive index (RI) detection and high-performance anion-exchange chromatography with pulse amperometric detection (HPAE-PAD) have become more popular techniques in recent years, they too offer challenges.

Titration is perhaps the most outdated method. Time-consuming, with laborious workflows, titration can only be performed by specialist technicians and then only to measure reducing sugars; sucrose simply can't be measured by this technique. Due to the technique's limitations, only high concentrations can be detected and,

with large sample and reagents volumes needed, large waste streams are generated. For these reasons, titration has largely been replaced by HPLC-RI or enzymatic methods in many manufacturing-based QA/QC laboratories.

Although HPLC-RI can provide excellent results for high-concentration sugar analysis, it is severely limited by matrix effects, requiring pre-sample clean-up which adds valuable time to an already lengthy process. With manual operation and control of incubation conditions, highly skilled technicians are needed for repetitive and time-consuming tasks.

The highly selective and sensitive HPAE-PAD technique is used to detect lower sugar concentrations and there is good evidence to support this technique for the [simultaneous analysis](#) of mono- and disaccharides. Modern high-performance ion chromatography (HPIC) systems with automated eluent generation simplify carbohydrate separation in complex sample matrices. However, the HPAE-PAD method still requires expert operation and long run-times, two commodities in scarce supply in the modern QA/QC laboratory.

For many manufacturing processes, sugar analysis is just one testing component of a multi-parameter repertoire. The beer and spirit manufacturing industry, for example, requires the testing of multiple organic and inorganic molecules, as well as pH (Figure 2). Traditional techniques need to be combined to deliver this multi-parameter array, putting extra pressure on stretched laboratories and limiting the capacity to provide rapid and accurate results.

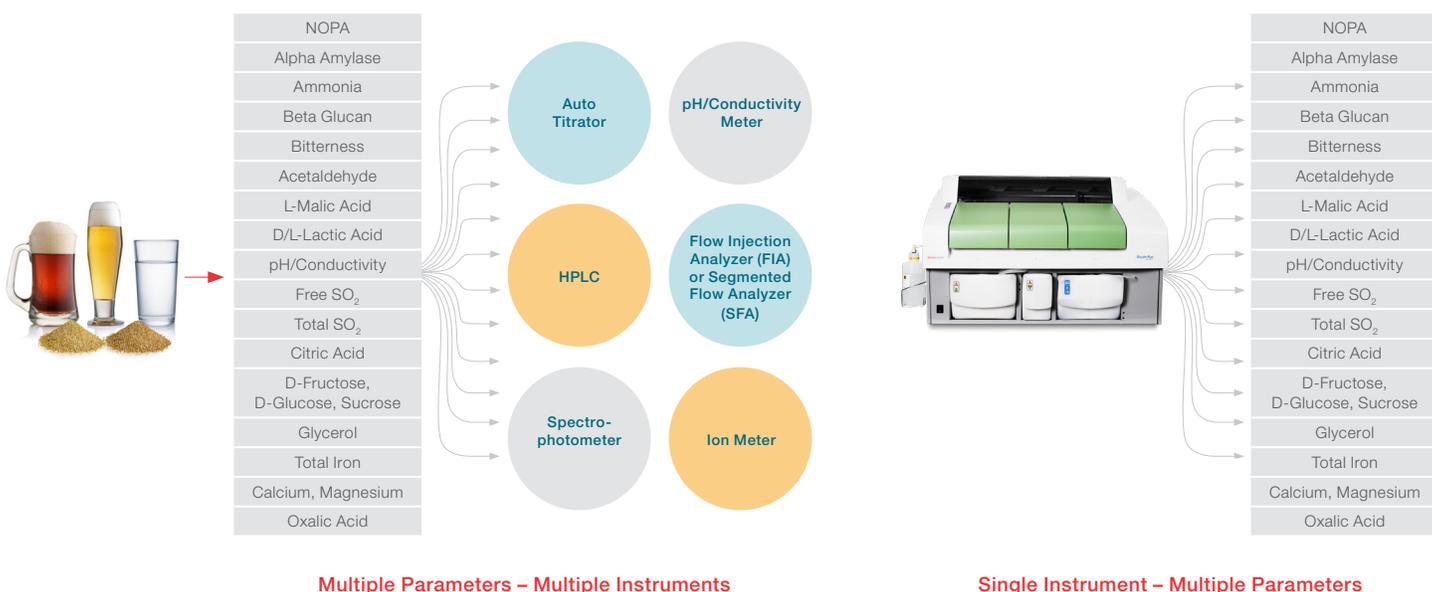


Figure 2. Multiparameter testing requirements in the beer and spirit manufacturing industry are met by discrete analyzer technology.

Discrete analyzers: combining highly selective enzymatic analysis with automation

Although enzymatic methods with photometric detection offer the highest selectivity and sensitivity for sugar analysis, they are often disregarded. A large number of manual processing steps and restrictive incubation temperatures mean that laboratories can only process a few samples a day and this simply isn't feasible in modern laboratories that can be expected to produce up to hundreds of results daily.

A new breed of discrete analyzers (DAs) is starting to change the landscape for enzymatic methods with photometric detection. By automating the entire testing process, laboratories can now take advantage of the selectivity and sensitivity offered by this technique in a fast, reliable and economical way. With next-generation DAs, incubation temperature is accurately controlled, sample sizes are dramatically reduced, and ready-to-use reagent kits in barcoded containers require very little input from technicians. Technicians run multi-parameter tests in a fully automated environment that requires a much lower level of expertise, leaving highly skilled scientists to provide added-value services instead of routine testing.

Thermo Scientific Gallery and Gallery Plus Discrete Analyzers

Thermo Scientific™ Gallery™ and Gallery™ Plus Discrete Analyzers provide complete solutions for rapid sugar analysis through enzymatic photometric methods (Figure 3). The fully enclosed, benchtop design provides fully-automated sample and reagent dispensing, mixing, incubation, photometric measurement and interpretation. Technicians simply load samples, ready-to-use reagents

and cuvettes, then import and select the sample table from the connected laboratory information management system (LIMS). The operator can then walk away while the Gallery Discrete Analyzer completes the analysis.

The Gallery Discrete Analyzer combines multi-parameter testing capability into a single instrument. Over 50 pre-defined, ready-to-use reagents are available for rapid reducing and non-reducing sugar analysis, as well as a broad of wider parameters, including organic acids, pH, conductivity, ions, nutrients and process-critical and environmental target analytes. Up to 20 parameters can be analyzed from one sample in one instrument, removing the need for multiple tests, techniques and technician time.

With precise dosing, sample and reagent volumes are reduced from milliliters to microliters, substantially reducing reagent costs and waste streams. The automated reagent and sample addition and mixing also reduces human intervention and manual workflow errors. Chemical testing is augmented with the use of highly sensitive electrochemical probes to provide accurate pH and conductivity analysis, in parallel to photometric tests.

Gallery Discrete Analyzers enable the creation of pre-defined, standardized workflows. Training programs are reduced, equipment set-up is much easier, and the operator can simply walk away to concentrate on value-added work while tests are conducted to the very highest standards. With barcode tracking on both samples and reagents, full traceability is guaranteed, providing the full Certificate of Analysis (CoA) needed for many quality assurance processes.

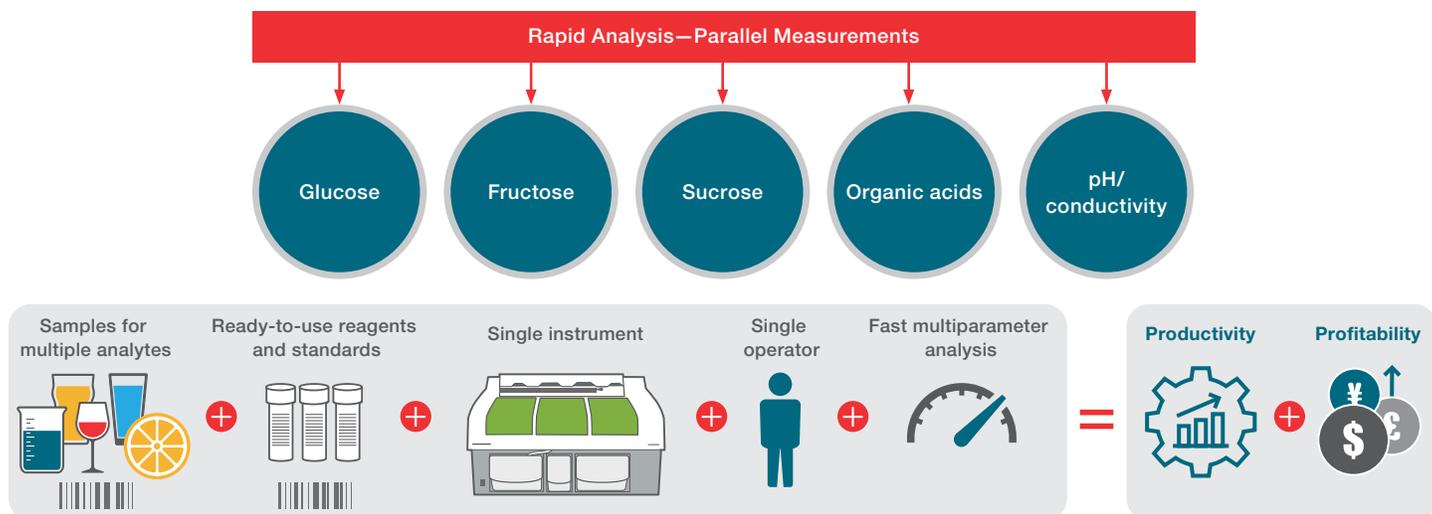


Figure 3. Rapid analysis of multiple parameters leads to increased productivity and profitability.

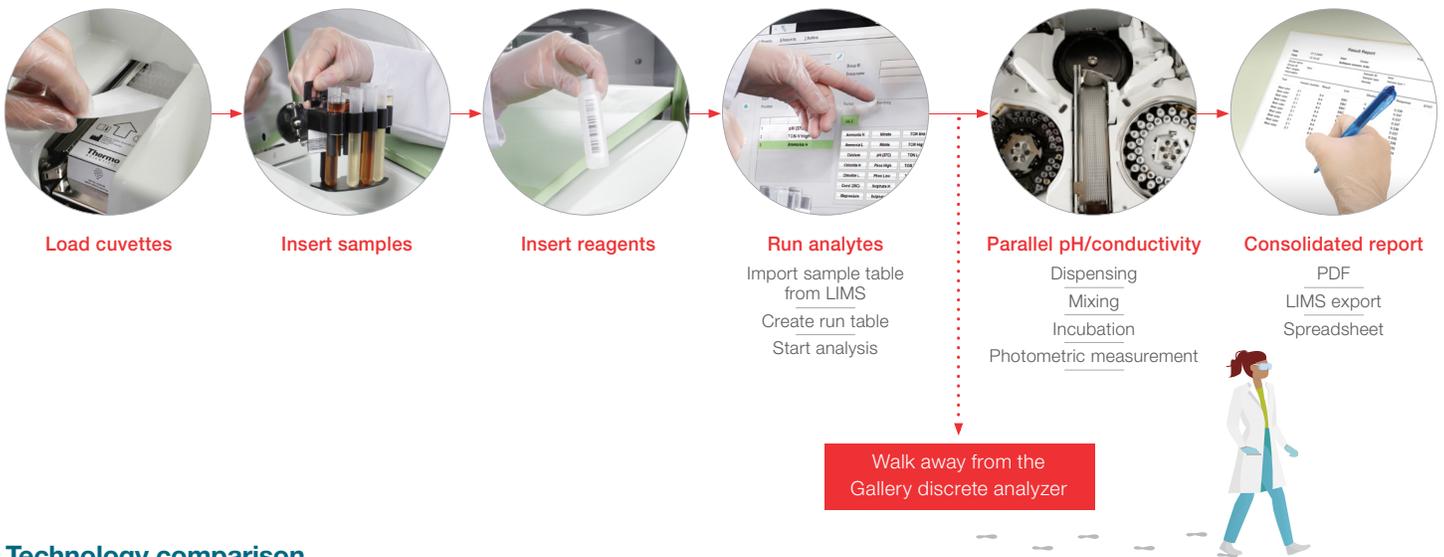
Improving quality standards by increasing throughput

By conducting enzymatic photometric analysis through the Gallery or Gallery Plus Discrete Analyzer, laboratories can replace multiple, laborious and technically demanding techniques with a single, bench-top platform. Throughputs of up to 350 tests per hour can now be achieved for multi-parameter testing, including sugar analysis.

Pre-defined, ready-to-use reagents mean that only microliters are used for each test, creating only milliliters of waste, compared to the liters expected through standard techniques such as titration and HPLC. Together with the reduced sample volumes and technician time, laboratories can expect to reduce the cost per analysis by a factor of 20, when compared to traditional methods.

By automating previously manual tasks, technicians reduce errors that are an inherent risk of manual processes while accessing the most selective and sensitive technique for sugar analysis. What's more, technicians can now focus on areas of quality assurance that add future benefit to the business rather than running repetitive tests.

The Gallery Discrete Analyzer helps laboratories reach the high throughputs demanded by a fast-paced manufacturing environment at a fraction of the cost of traditional methods. Increasing the spectrum, frequency and rate of parameter testing start the shift towards a continuous monitoring model, which means that manufacturing teams can make more accurate decisions. In turn, this leads to increased product quality and greater manufacturing speeds. Whatever the process, whether it's brewing the perfect pint or refining biopharmaceutical fermentation to create novel biologics, rapid, specific and selective analysis is the only way to harness the full power of the QA/QC laboratory.



Technology comparison

Traditional wet chemistry

- Labor Intensive
- Highly skilled operators
- Multiple instruments
- Few parameters
- Low throughput



Gallery Discrete Analyzer platform

- Easy to use
- Suitable for all user levels
- Single platform with walkaway efficiency
- Up to 20 different parameters
- High throughput up to 200–360 tests/Hr

Figure 4. Gallery Discrete Analyzer provides unparalleled specificity, selectively, and productivity.

Find out more at thermofisher.com/discreteanalysis

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