Milking parlour management – balancing demand with safety

Dairy products are amongst the most sought-after food groups in the world, providing nutrients to people worldwide, and a key component of many diets in developing countries. Demand is continuing to grow as we see populations rise, along with a higher demand for calorie-dense diets within developing countries.

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Looking at the UK alone, milk accounted for 16.4% of total agricultural output in 2020, producing 15.3 billion litres of milk, the highest annual figure since 1990.

For dairy producers, it has never been more crucial to safeguard against potential contamination, protecting both their supply and consumers from chemical hazards and toxic heavy metals.

In 2008 came the Chinese milk incident, where milk and infant formula was adulterated by farmers with melamine. This was used to increase protein levels, leading to six deaths and further affecting 300,000 individuals.

Since then, there has been increased attention on the safety of milk production from both authorities and consumers. This has meant increased regulatory and QA/QC analyses are required to test the milk before it enters the global supply chain.

Additionally, attention to the compositional quality of dairy is paramount in today's competitive market to ensure accurate and optimal protein, fat and lactose composition as well as the absence of adulteration through water or other more concerning additives.

Determining milk's nutritional value

Milk is a particularly nutrient-rich liquid. Its nutritional composition varies among animal species and breeds within the same species, and also from one dairy to the other, depending on the period of a cow's lactation and diet.

Consistent monitoring of the compositional analysis of milk delivers deeper insights into overall herd health, allowing farmers to selectively improve milk composition and the total milk yield of their herds. This is undertaken by analysing collected milk for specific health markers such as somatic cell count, which indicates the quality of milk, and non-esterified fatty acids in milk, an important type of metabolic fuel which indicate energy levels.

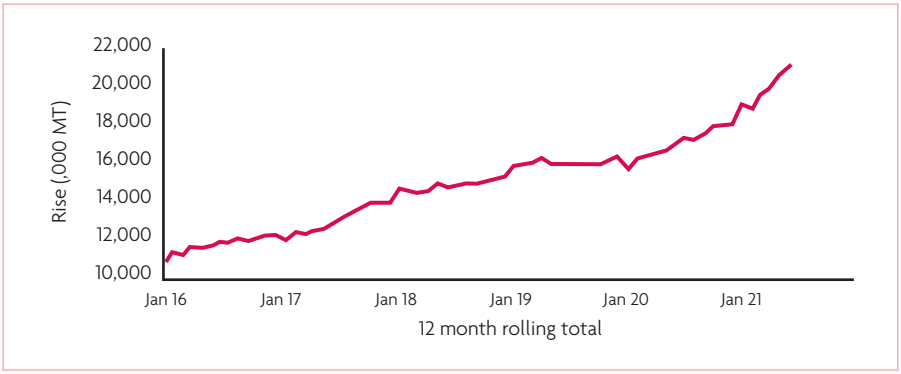
Most importantly, the composition of milk has a direct impact on its commercial value. As dietary trends evolve, such as an increase in those seeking a protein-dense product, or a product with lower fat levels, farmers are therefore able to market their product based on nutritional value and demand.

Business priorities for dairy manufacturers

Across the world we are seeing changes within the industry. Tighter profit margins, intensifying competition, rising regulations and consumer demand for sustainability are leading trends, driving manufacturers of dairy products to scrutinise the efficiency of their industrial processes.

Any possible gains in process efficiency can provide a dairy manufacturer with a strong competitive edge by enabling them to make the best use of their raw materials – maximising production of sellable products and increasing profit margins. One illustrative example for this is the work and time involved in the 'fat reference method', popular amongst milk producers.

Fig. 1. Chinese milk-equivalent imports rise (GTT, StoneX Calculations).



This visual method varies and depends on the user's appreciation of the milk's fat at the measuring device, which can lead to some fat losses due to human error. Performing this technique and obtaining results takes around 20 minutes – time that could have an impact on profitability.

Near-infrared (NI) and infrared (IR) instruments provide easy to use solutions that deliver reliable results quickly and enable insightful decision making at earlier points in the food chain. At milk collection points, for example, simple push button IR-based analysers, such as PerkinElmer's IndiScope, produce real-time results for fat, protein content, and adulterant screening, in just 30 seconds. More informed on-the-spot decisions on payment, quality, and safety can be done by using these robust, portable tools.

The rapid and accurate analysis of the composition of the key substances of raw milk is of paramount importance in this industry to enhance and guarantee the quality of finished products.

Analyses prevent health risks posed by adulterated loose milk, i.e. milk which is sold in bulk and untested, entering the production and ending on consumers' tables. For this reason, milk processors and dairies across the globe are challenged with ensuring the safety, but at the same time the consistency of incoming raw materials.

Maintaining these standards can also prevent the brand damage that can occur when an incident becomes public knowledge.

Monitoring for antibiotics, detergents and pesticides

If antibiotics, detergents and pesticides get into milk, producers are faced with significant problems. In addition to economic losses, there is the threat of drug tests, inspections by authorities and there could even be criminal consequences if, for example, antibiotics are detected in the milk delivered.

State-of-the-art testing technologies ultimately benefit consumers, who have a high interest in consuming high quality, uncontaminated milk. Additionally, with producers feeling an increasing pressure on their margins, it is key for them to find solutions that can help them optimise their production and quickly determine the quality of the milk for pricing purposes.

Monitoring for aflatoxin M1

Aflatoxin M1 is a metabolite of aflatoxin B1, commonly found in dairy products. The presence of aflatoxin M1 occurs when dairy cattle ingest feed which is contaminated with aflatoxin B1.

This is a risk for dairy producers as aflatoxins are known to be carcinogenic, therefore sampling and monitoring procedures are strictly enforced for consumer safety. In the EU, there is an imposed action limit of 0.05 parts per billion (ppb) of aflatoxin M1 in milk and 0.025ppb for infant formula.

Monitoring for metal

Milk is often described as a 'complete food' as it contains a wide variety of the macro and micronutrients required for a healthy human diet. As cows produce milk, the nutrients from their feed are incorporated, and so milk becomes a good source of the zinc, calcium and selenium naturally found in grass.

However, along with these beneficial nutrients, harmful metals commonly accumulate in air, soil, water, and plants. If the cow's feed is contaminated with the common pollutants lead or cadmium, this may also be passed into the milk and lead to serious consequences for consumer health.

Milk is one of the products with the highest contamination of this type. The presence of toxic metals as well as the quality of the feed itself can be affected by multiple factors ranging from the genetics of the animal, to post-production and packaging processes.

Detecting heavy metal contamination in food using accurate testing and analytical methods is an important part of preventive health care.

Without intervention, the health effects of cadmium and lead, as well as other pollutants such as mercury, are significant, risking cancer, cardiovascular disease, and neurological problems.

Further, lead causes a wide variety of negative effects, including premature births and miscarriages, as well as brain, liver, and kidney damage.

Cadmium, a highly toxic heavy metal, prematurely ages cells and is classified as a human carcinogen (Group 1), according to the International Agency for Research on Cancer.

This further reinforces the requirement for sophisticated detection techniques through existing analytical instruments, and the continuing research within this sector.

Methods and tools used for innovative analysis

Official associations, such as Association of Agricultural Chemists (AOAC) International, have identified official methods for the compositional analysis of milk.

The Kjeldahl method is the most known for protein measurement, though it is a manual method and requires the use of toxic chemicals. Other technologies, as FT-IR (Fourier-Transform Infrared Spectroscopy) or Mid-IR, represent alternatives that are more efficient.

These often laboratory-based methods enable the testing of raw, standardised and

processed milks, whey, cream and other dairy products, determining a range of parameters, including butter fat, protein, lactose, total solids, solids non-fat (SNF), and added water.

For example, PerkinElmer's FT-IR instrument, the LactoScope, uses patented mid-IR technology for a quick measuring time of 30-45 seconds with a typical accuracy of under 1% CV.

Further to this, other FT-IR solutions analyse the composition of raw milk at the point of collection, rather than in labs, helping milk producers and dairy factories perform fast and accurate tests, such as the portable IndiScope.

By analysing the fat and protein content of the milk as well as detecting the potential presence of adulterants such as water, maltodextrin and urea, the method helps to create a safe raw milk supply chain for consumers, and helps achieve fair pricing for all the parties involved.

Building on this is the demand for quicker on-site screening methods, to help farmers swiftly identify potential food safety incidents.

Using a similar technology to Covid-19 rapid testing, AuroFlow Lateral Flow Test Strips can detect 14 beta-lactam antibiotics, major tetracyclines, and 11 major sulphonamides in milk at or below EU and CODEX maximum residue limits.

Kits such as these allow simultaneous detection of different classes of antibiotic residues in raw, commingled cow's milk.

Global demand for milk and other dairy products is continuing to grow due to population growth, urbanisation and the westernisation of diets in countries such as China and India. In China in particular, throughout 2021 we saw rising foodservice sales, increasingly high domestic milk prices, along with government messaging around the health benefits of milk. This therefore resulted in a strong demand for China's import of milk, something set to continue in 2022.

No matter where milk is farmed, distributed or consumed, efficient testing is of the utmost importance for both suppliers and consumers.

As new adulterants, regulations and standards and consumer demand trends inevitably enter the global supply chain, the industry must continually add new and innovative solutions to its testing and analysis capabilities to keep dairy players ahead of the curve. ■