Milk Industry

Problem Statement

In the dairy industry, the quality of milk received from farmers is still often tested using olfactory tests. A specialist takes a milk sample and determines its quality by smell. It's also important to note that each producer develops its own milk quality scale. These milk quality testing methods, while highly effective, remain highly subjective. While this method helps separate spoiled raw milk from normal milk, it can also discard quality milk with a suspicious odour, leading to production losses. While human-based quality control is highly effective, it is also susceptible to numerous errors and external factors.

It's important to note that milk is also transported at a specific temperature, but various factors can cause this temperature to deviate, potentially resulting in spoilage of the entire batch of milk, which may be rejected by a quality specialist or allowed into production.

Solution

Thanks to a series of high-precision sensors, the eNose device can assess milk quality and provide results within 1–3 minutes.

Description of the eNose device

Please read eNose brochure.

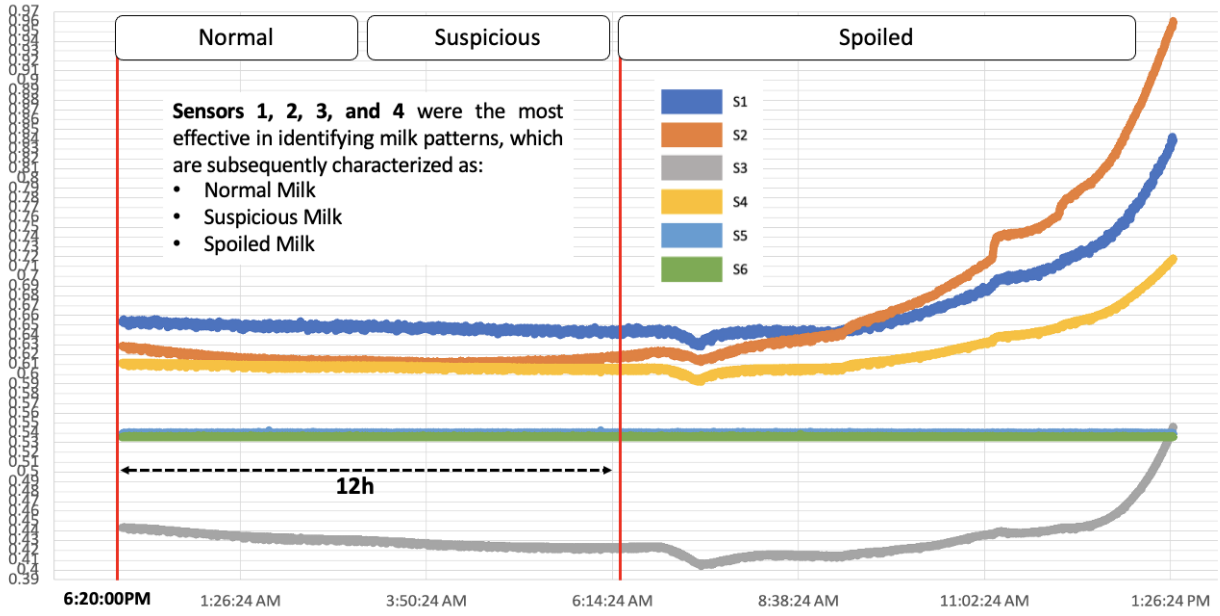


What do we know about the industry and what can we do?

- We can distinguish normal raw milk from sour milk,
- We can identify various impurities in normal raw milk,
- We can potentially distinguish normal raw cream from sour cream (additional tests are required),
- We can potentially identify various impurities in normal raw cream.

Principles of working with clients from the dairy industry:

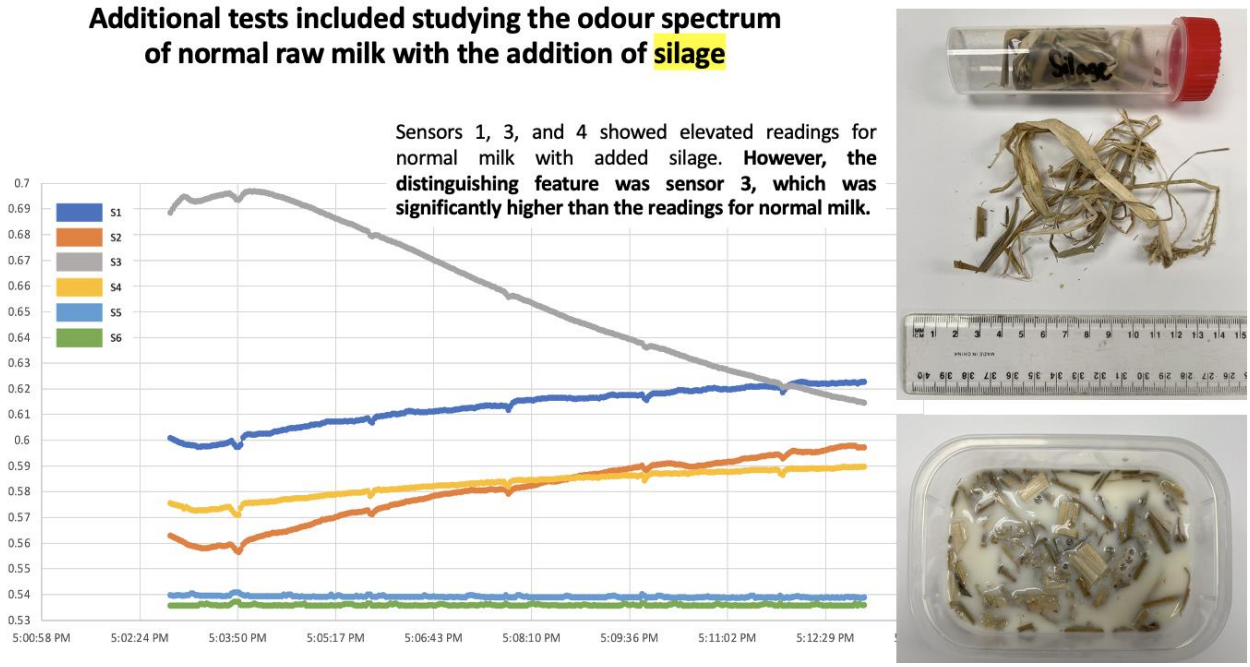
As practice shows, each company has its own definition of fresh and sour milk. Therefore, we rely on data we've discovered ourselves during our own testing. Specifically, during the first 12 hours of being unrefrigerated, milk remains normal, and only after these first 12 hours are slight increases in volatile compounds observed. **In other words, milk remains normal for the first 12 hours of being unrefrigerated, and only then does souring begin.**



*S1 – TGS 2600, S2 – TGS 2602, S3 – TGS 2603, S4 – TGS 2620, S5 – FESC 44-200, S6 – FESC 50-100.

Furthermore, we know that each producer has its own set of impurities they would like to identify in normal raw milk.

For example, producers themselves report that if a cow eats onion grass, the milk acquires a bitter taste, which they try to avoid. They also want to distinguish other impurities, such as garlic, chemical cleaners, grain, silage, and so on.



*S1 – TGS 2600, S2 – TGS 2602, S3 – TGS 2603, S4 – TGS 2620, S5 – FESC 44-200, S6 – FESC 50-100.

(Important!) It is necessary to clarify with the manufacturer in detail which impurities they want to determine and in which dairy product (milk, cream, etc.), since a unique pattern will be created for each case, which can subsequently be used as a reference.

Steps to implementation when interacting with dairy producers:

1) Determine the client's interest in the device and the quality of the products they plan to identify.

2) For each product (milk, cream, etc.), a unique pattern must be created, which will subsequently serve as a reference for determining product quality.

For example, if a pattern needs to be created for raw milk, a series of tests are conducted to determine the volatile compound limits for normal raw milk and spoiled raw milk (Pattern: Normal Raw Milk – Spoiled Raw Milk).

If the manufacturer wishes to identify any adulterants in this milk, this will be assessed as the creation of a new pattern (Pattern: Normal Raw Milk – Normal Raw Milk with Adulterant). One pattern will correspond to one impurity.

3) After outlining the future patterns, it is important to explain to the client that we need to conduct a series of tests with the eNose device to collect initial data, which will be used to create the pattern. 4) To collect data, we provide the client with a temporary eNose device, which they install at their production site. This is necessary to simulate the same testing conditions as closely as possible. The device is very sensitive, and therefore it is important to conduct testing under conditions that will subsequently be consistent for the device.

(Important!) We need to conduct as long a test as possible with at least one client at their production site (e.g., 4 weeks). This is necessary to collect the necessary data and build a preliminary pattern. Subsequently, we likely won't need to test the device for as long with subsequent clients in the same industry, since we will already have a preliminary pattern that will require only minor adjustments. Therefore, the duration of this testing at the client's site can be reduced to 1 week or even a few days.

5) After the testing phase, the device is removed from the client, and a break is taken for data analysis and pattern development. This process typically takes 2 to 4 weeks per pattern.

Testing Plan

1) **Objective**

The objective of this testing phase is to validate the effectiveness of the eNose system in detecting spoilage in raw milk and cream using AI-driven, objective analysis, reducing reliance on subjective human sensory evaluation.

2) **Testing Duration**

- **Total Duration:** 4 weeks
- **Frequency:** 5 days per week (Monday to Friday)

Optional: Seasonal testing can be conducted every 3 months if required.

3) **Daily Testing Schedule**

- **09:00 – 09:05** → Device power ON
- **09:05 – 10:00** → Sensor warm-up
- **10:00 – 16:00** → Sample testing
- **16:00 – 16:10** → Chamber ventilation and device shutdown

4) **Testing Scenarios**

Testing can be carried out in various scenarios, depending on the type of dairy product and client preferences, such as:

- **Scenario A:** Fresh raw milk (~100 mL)
- **Scenario B:** Fresh raw milk + fresh raw cream (~100 mL each)
- **Scenario C:** Fresh raw milk/cream + spoiled raw milk/cream (~100 mL each)
- **Scenario D:** Custom scenario based on client requirements

Final scenarios will be agreed upon prior to testing.

5) **Testing Procedure**

1. Collect approximately 100 mL of sample
2. Pour into designated container
3. Place container inside the eNose testing chamber
4. Seal the chamber to prevent external contamination
5. Allow sample to remain for defined testing duration
6. Remove sample after testing
7. Ventilate chamber before next sample

6) Testing Duration per Sample

- **Scenario A:** ~6 hours continuous testing
- **Scenarios B & C:** Sequential testing (N hours per sample)
- Duration may be adjusted during testing based on observations

7) Client Responsibilities

- Place samples into the testing chamber
- Record and share:
    - Time of placement
    - Time of removal
- Ensure proper handling of samples

8) Remote Monitoring & Support

- The iOmniscient team will monitor testing remotely
- Real-time support will be provided
- Adjustments to testing parameters may be suggested during execution

9) Notes & Flexibility

- Testing durations may be optimized during the process
- Additional scenarios can be introduced if required
- Continuous feedback loop between client and iOmni team

How to analyze the obtained results:

1) Before conducting a test, you should keep a test log and record the times of tests so you can later find this data in the downloaded table. It's important to understand that once a test begins, the device continuously records sensor readings until the test is stopped. The device records sensor data in date-time-value format (see table below). The date is represented as year-month-day. Time is represented as hours-minutes-

seconds. Keeping a test log will allow you to understand what time the test started and ended and extract this information from the table.

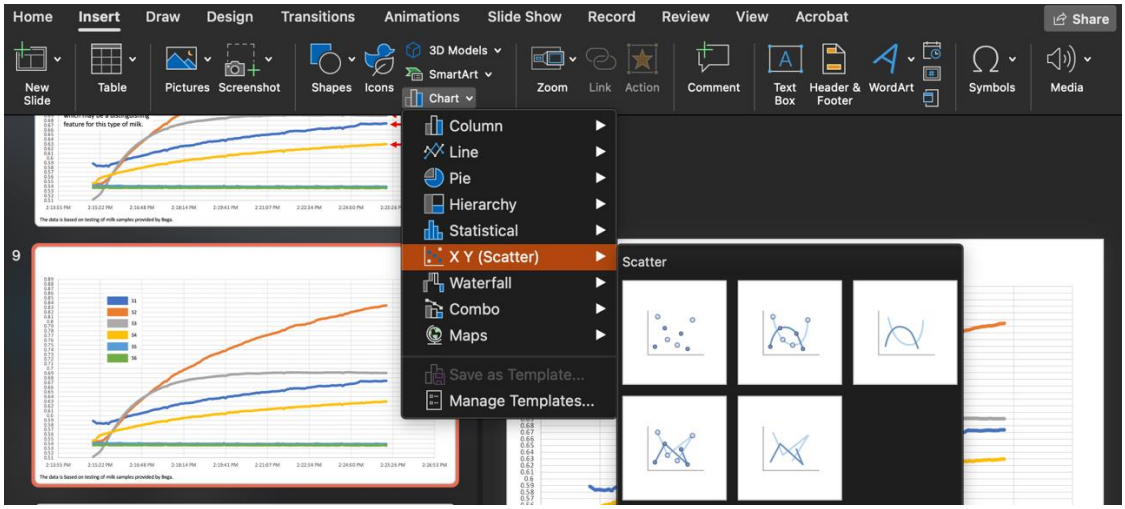
2) Once all the data has been captured and the planned tests are completed, the data is extracted from the device. Kevin will explain how to do this. The data is extracted as an Excel spreadsheet. **An example is shown below**.

Long Test_RM26_Part 1

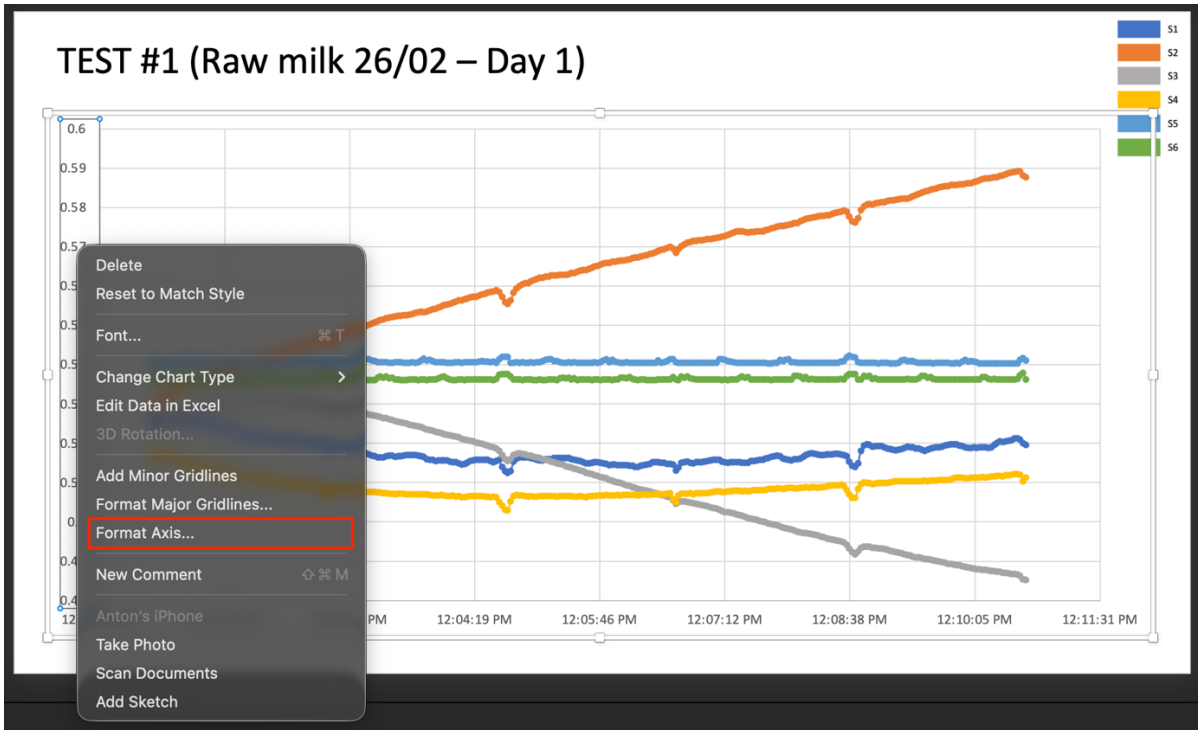
Timestamp	Sensor1	Sensor2	Sensor3	Sensor4	Sensor5	Sensor6
2026-02-26 18:19:04	0.58578	0.54911	0.57209	0.56039	0.53975	0.53622
2026-02-26 18:19:06	0.58581	0.54925	0.57227	0.56058	0.5398	0.53702
2026-02-26 18:19:08	0.58584	0.54936	0.57234	0.56059	0.5398	0.5365
2026-02-26 18:19:10	0.58552	0.54934	0.57219	0.56022	0.5397	0.53684
2026-02-26 18:19:12	0.58544	0.54955	0.57217	0.56042	0.5397	0.53661
2026-02-26 18:19:14	0.58547	0.54966	0.57212	0.56044	0.53977	0.5362
2026-02-26 18:19:16	0.58528	0.54964	0.57202	0.56031	0.5398	0.53617
2026-02-26 18:19:18	0.58536	0.54986	0.57198	0.56025	0.53969	0.53614

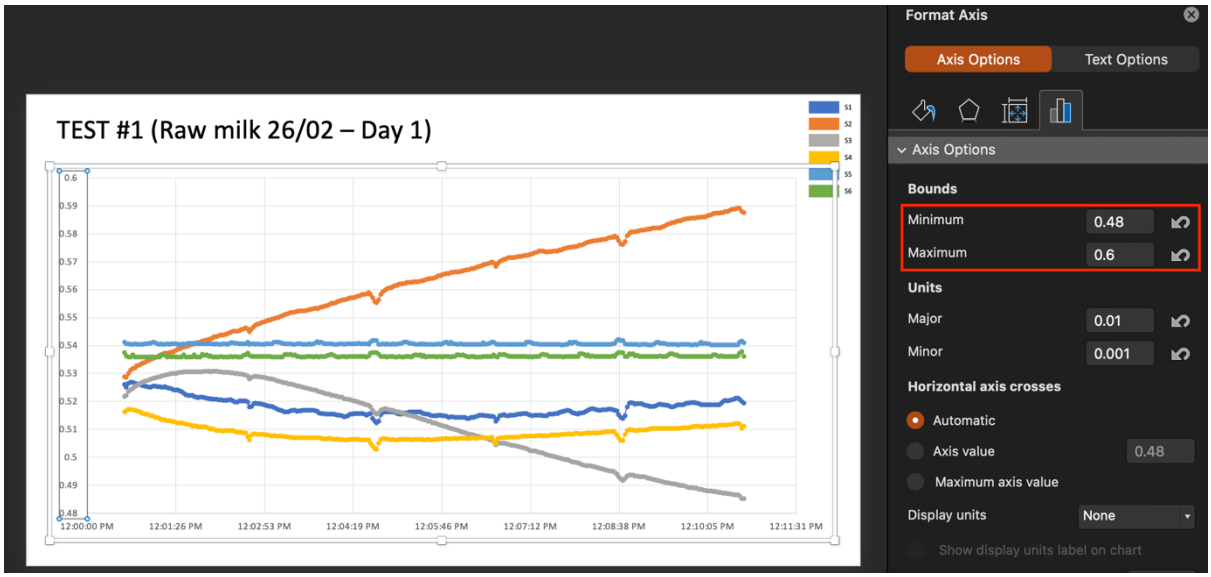
3) There are several ways to convert the necessary data from an Excel spreadsheet into a fully functional graph. The first is to create the graph in the same Excel file. The second is to copy the necessary data from the spreadsheet and create the graph in a PowerPoint presentation (preferred method).

4) Before copying data from a table, you must first select the appropriate settings in the Power Point: Insert – Chart – X Y (Scatter) – Dots with lines / Lines. For clarity, **see the screenshot below**.

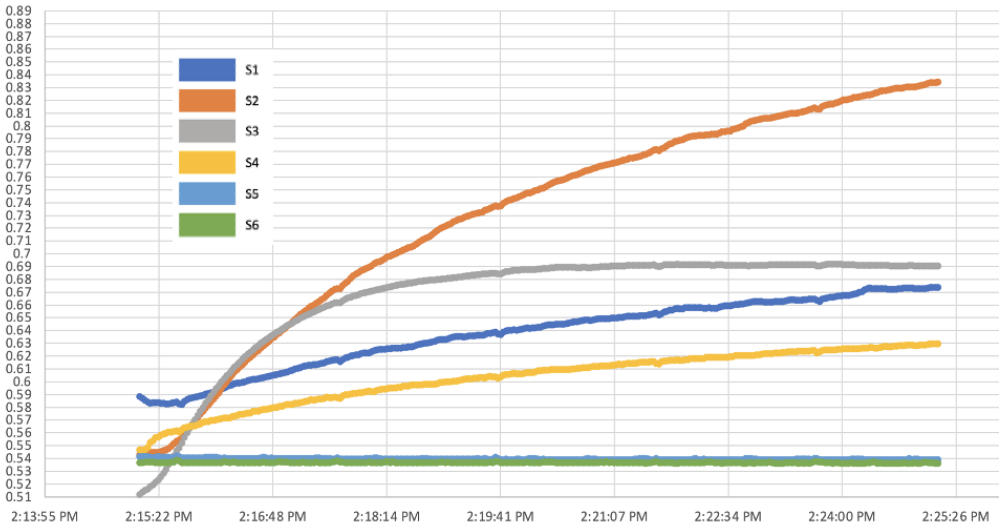


5) It's likely that when the graph is plotted, it will be a jumble of various straight lines that won't make any sense. Additional manipulation will be necessary to stretch the graph. The graph has two axes: the horizontal axis represents time, and the vertical axis represents the corresponding quantitative values of the gases identified by the sensors. To stretch the graph, you need to change the vertical axis parameters so that the initial level is not 0, but a different number (selected individually). By plotting the upper and lower boundaries in this way, you can create a high-quality graph. **See the tip below**.





6) Once all the settings are set (if necessary), analyze the resulting chart and identify patterns (this could be a peak, plateau, or sharp decline) that will help identify the main patterns. Recommendation: It's advisable to run the same test 2-3 times to obtain clearer results from all three versions. If a certain pattern appears on all three test charts, it's likely that this pattern can be used as the primary one and monitored for further changes in subsequent tests as other parameters are adjusted.



(Important!) A pattern is a sequence of repeating events that occur with the same type of sample (For example, raw normal milk or raw sour milk) in different tests. For example, during the day a test was carried out on normal raw milk and in each test there were no peaks in the increase in the concentration of volatile compounds, and vice versa for raw sour milk, an increase in the concentrations of certain substances (and sensor readings) was observed.