Automated Quality Control of Fermented Milk Drinks

Relevant for: Dairy Industry

Fermented dairy products are economically the most important food factor. Thus these products are subject of strong quality control regulations. Anton Paar´s density meters in combination with the sample changer Xsample 530 offer a fully automated solution to fulfill the high quality demands.

1 Introduction

In the following section we will present you a fully automated system using the Xsample 530 sample changer for filling and cleaning with a connected sample recovery unit (SRU), combined with a DMA density meter for measuring the specific gravity of fermented milk products.

1.1 Composition of milk

Milk and dairy products are very complex substances that are composed of an expansive diversity of different molecular species. Many factors affect the composition of raw milk, like kind and age of mammal or feeding [1]. Only an approximate milk composition of 87 % -88 % water and 12 % - 13 % total solids can be given. The major chemical components of milk include water, fats, proteins, carbohydrates, minerals, organic acids, enzymes and vitamins.

1.2 Fermented dairy products

Among the over 3500 traditional fermented foods existing worldwide, fermented milks have long been an important component of nutrition and diet [2].

Fermented milk products or fermented dairy products are dairy foods that have been fermented with lactic acid bacteria such as Lactobacillus, Lactococcus or Leuconostoc. The fermentation process increases the shelf life of the product while enhancing its taste and improving the digestibility of the milk [3].

Fermentation means the milk is partially digested by the bacteria. This makes the milk product easier to digest, especially for people who have milk allergies or are lactose-intolerant [4].

1.3 Specific gravity as quality parameter

The determination of physical parameters, such as the specific gravity of milk, plays an important role in the dairy industry. The measurement of specific gravity using Anton Paar´s density meters proves to be a fast and precise method for the detection of deviations of the milk composition.

The specific gravity, also called relative density, is the ratio of the density of a substance to that of a standard substance [5].

In our case it is the ratio of the density of milk to the density of water.

If the measured specific gravity changes, this could be for instance an indication that the water content is higher than normal.

1.4 Density measurement

The density measurement is a simple and robust method which provides a simple analysis parameter which is measured in process as well in laboratory.

The oscillating U-tube principle, which is applied in Anton Paar density meters, replaces older methods, such as hydrometers, pycnometers and lactometers.

1.5 Inclusion of air in dairy products

The inclusion of air strongly influences the density of milk and dairy products. Included air is trapped in viscous dairy products and escapes only very slowly or not at all [6]. This entrapped air may influence the density of dairy products and can lead to erroneous measurement results and bad repeatabilities.

2 Instrumentation

Fig. 1: Xsample 530 with DMA (without SRU)

2.1 Xsample 530 sample changer

The fully automatic Xsample 530 sample changer is used to fill the measuring cells from sample vials. Available standard magazines are 71 x 12 mL, 35 x 20 mL and 35 x 40 mL. Larger magazines are also available upon customer request. Its fully automatic filling, rinsing and drying of the entire system ensures reproducible results without any sample cross-contamination.

2.2 Sample recovery unit (SRU)

Typically the SRU is used to recover the sample back into the sample vial after analysis, which is a useful function for hazardous, toxic or expensive samples.

In this application report we use the advantage, that the SRU provides a suction mode for filling samples up to 1000 mPa.s without bubbles. The sample will be filled into the measuring cell of the master instrument by applying vacuum to the sample using the integrated piston pump.

2.3 DMA 4101/4501/5001 density meters

The Anton Paar density meters 4101/4501/5001 provide a convenient means of determining density with excellent accuracy using very small amounts of sample (sample cell holds approx. 1 mL) in very short time (typically 1 minute to 4 minutes).

Anton Paar laboratory density meters have been used successfully for quality control of dairy products for many years.

3 Measured samples

We measured several different fermented milk products delivered by a customer:
“Low fat”, “Plain”, “Mixed berries” and “Apple”

The target values for the individual samples were specified by the customer.

The samples were stored in a refrigerator to keep them cool and were freshly filled into the vials before measurement. No further sample preparation was done.

4 Measurement settings

4.1 System setup

Table 1: Recommended configuration for the system

Instrument	
Density Meter	DMA 4101/4501/5001
Sample Changer	Xsample 530
SRU	active
Magazine	35 x 45 mL (now discontinued and replaced by a 35 x 40 mL standard magazine)
Vials	45 mL
Air source	Internal air pump

TIP: To prevent condensation in the measuring cell due to a measurement temperature of 15 °C, we recommend using a drying cartridge.

4.2 Used cleaning solvents:

- Rinse 1: 2 % Mucasol in water
- Rinse 2: Water (distilled or deionized)
- Rinse 3: Ethanol VG 96

4.3 Method settings

Filling by suction:

The samples contain air bubbles (see 1.5) which greatly influence the filling quality and the subsequent measuring results.

To overcome this problem we installed a SRU (see 2.2) and used the filling mode “Suction”.

Table 2: Xsample settings

Settings	
Auto self-test before filling	No
Auto air-check before filling	No
Filling mode	Suction
Draining mode	With rinse 1
Overfill mode	Auto

Table 3: DMA settings

Settings	
Temperature	15 °C
Timeout	600 s
Filling Check™	Always active
Measurement delay	0 s
Precision class	Fast
Density stability criterion	Yes
Viscosity correction	Automatic

Table 4: Cleaning settings

Rinse	Cycles	Dry Time [s]	Cleaning Mode
2	2	0	High volume[1]
3	1	0	Sample recovery unit
3	1	300	Normal

[1]Used expert settings: 1 x dunk; 10 s soak

5 Results

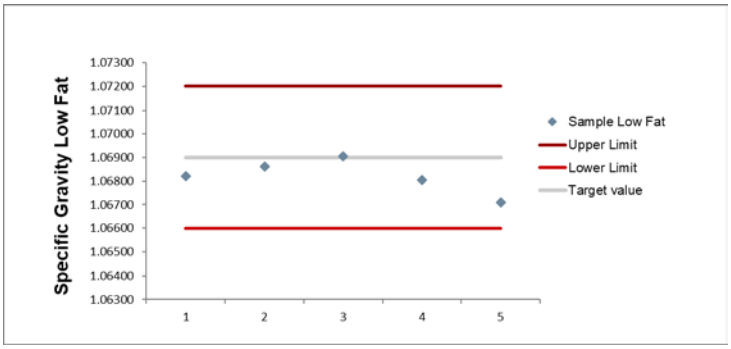
The following table shows the measurement results obtained with installed SRU and suction mode.

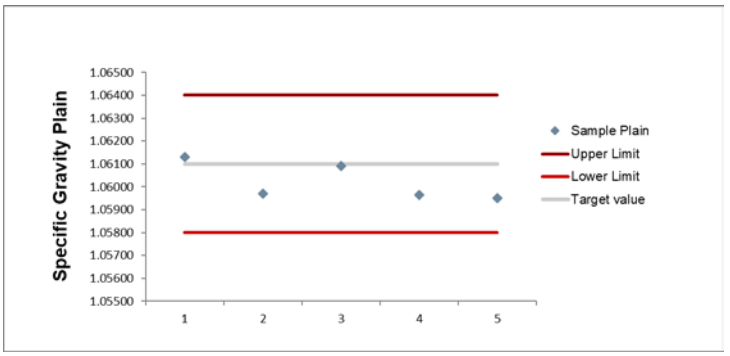
It can be seen that the measurement results fit perfectly to the target specifications of the customer.

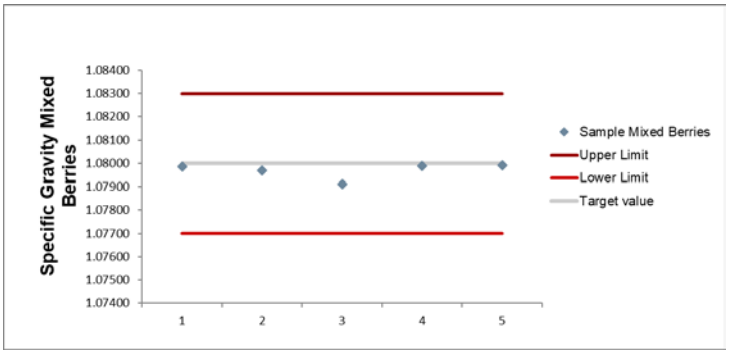
Table 5: Measured specific gravity versus target value

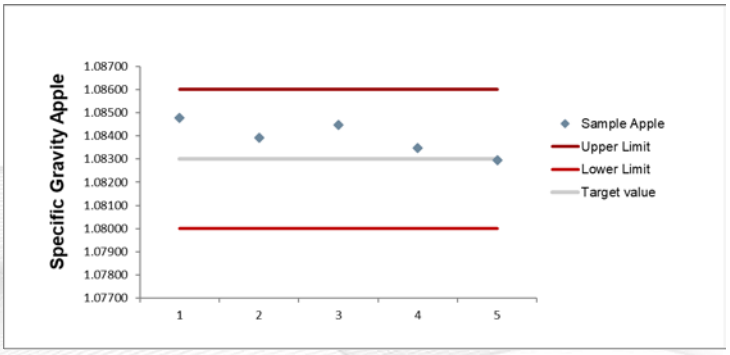
Product	Specific gravity measured with installed SRU (n = 5)	Target value specific gravity
“Low fat”	1.0682 ± 0.0006	**1.0690 ± 0.003**
“Plain”	1.0602 ± 0.0007	**1.0610 ± 0.003**
“Mixed berries”	1.0798 ± 0.0003	**1.0800 ± 0.003**
“Apple”	1.0839 ± 0.0007	**1.0830 ± 0.003**

The graphs below show the individual measurement values for the different samples. It can be seen that the measurement values are well around the target value and all measurement values are within the upper and lower limits.









Conclusion

This report clearly shows that it is not enough to have a perfect measuring system - only in combination with the correct filling procedure reliable results can be achieved.

Fermented milk products, which contain trapped air bubbles, are difficult to fill without bubbles which subsequently leads to filling warnings and wrong measuring results.

In this application report it has been shown that for fermented dairy products, the suction mode with SRU shows good measurement results.

The combination of DMA 4101/4501/5001 with Xsample 530 and SRU is a good solution for automated measurements of fermented milk products for quality control.

Using the Xsample 530 sample changer offers additionally several advantages:

- The filling procedure is predefined, user-independent and fully automatically; errors caused by the operator are reduced to a minimum.
- Due to the automated system time can be saved, parallel work of the operator is enabled; analysis can be carried out while the next sample is automatically processed.
- According to the application different filling modes can be chosen.
- The cleaning procedures are configurable with a variety of options to set the perfect cleaning for your sample type.
- Three different rinsing agents can be used to ensure best cleaning performance, even hard to clean samples are no big issue for Xsample 530 and cross-contamination is prevented.
- The needle is cleaned inside and outside for high cleaning performance.

6 References

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