

Process Control for Fat and Moisture/Solids Content in Dairy Products



Introduction

Consumer demand for dairy products is at an all-time high, with global consumption expected to grow at a rate of 1.8% per year over the next ten years. Fat and moisture testing for dairy products has traditionally been done by wet chemistry techniques, which are time consuming and often involve skilled technicians and hazardous solvents. Various rapid techniques (TD-NMR, NIR, FT-IR, and FT-NIR) have been introduced, but none have been universally accepted due to the need for often extensive calibration development and maintenance.

The ORACLE™ is a rapid time domain NMR (TD-NMR) instrument incorporating proprietary technology that allows for direct determination of fat/oil in foodstuffs. Unlike other rapid techniques, the ORACLE is able to completely isolate the detection of fat in complex matrices which eliminates the need for calibration. To allow for rapid moisture/solids as well as fat testing, the ORACLE can be coupled with a SMART 6™ moisture/solids analyzer.

To demonstrate the ability of the ORACLE and SMART 6 to accurately and reliably determine the fat and moisture content in dairy samples, an assortment of 11 samples were obtained and analyzed. The samples were selected to represent a range of both matrix types as well as relative component concentrations.

Key System Benefits of ORACLE with SMART 6

- Direct technique, requiring no calibration
- Rapid analysis (less than 5 minutes for moisture and fat)
- Bulk measurement (insensitive to color and granularity)
- Better repeatability than reference methods

Experimental

To complete each analysis, the samples were pre-dried on the SMART 6 for approximately 3 minutes and then prepared for analysis in the ORACLE. Once inserted into the ORACLE magnet, the samples undergo a 35 second scan for NMR analysis. Altogether, the time required to obtain moisture and fat results was between 4 and 5 minutes. Sample sizes ranged from 2 – 3 grams. Each sample was analyzed in duplicate for the reference analyses (AOAC approved methods) and in triplicate for the SMART 6 – ORACLE analyses.

Note: High-throughput analyses can be enabled through the use of batch automation using an optional robot and high capacity heater blocks (100 positions) as shown in **Figure 1**.

Results and Discussion

The accuracy of the SMART 6 and ORACLE results is demonstrated in **Table 1**, where the average reference results are compared with the average of the SMART 6 and ORACLE results. The average difference ranged from 0.01 – 0.13 % for moisture/solids, and from 0.00 – 0.09 % for fat. Repeatability is shown in **Table 2**, where the standard deviations ranged from 0.01 – 0.09 % for moisture/solids, and from 0.01 – 0.12 % for fat.



Figure 1: ORACLE with High-throughput Robot Accessory and Heater Blocks

Table 1: Accuracy of the SMART 6 – ORACLE for Moisture/Solids and Fat in Various Dairy Matrices

Sample	Moisture/Solids			Fat		
	SMART 6	Oven	Difference	ORACLE	Mojonnier	Difference
Skim Milk	9.28	9.26	0.02	0.19	0.18	0.01
Yogurt	20.69	20.56	0.13	1.17	1.15	0.02
Low Fat Milk	10.95	10.91	0.04	2.00	2.01	0.01
Whole Milk	11.88	11.89	0.01	3.20	3.18	0.02
Ice Cream	39.13	39.07	0.06	13.52	13.56	0.04
Half & Half	18.44	18.47	0.03	10.08	10.08	0.00
Processed Cheese	41.58	41.50	0.08	30.98	31.02	0.04
Natural Cheese	37.07	37.03	0.04	32.74	32.72	0.02
Cream Cheese	65.44	65.40	0.04	22.85	22.91	0.06
Cream	46.88	46.86	0.02	41.54	41.58	0.04
Sour Cream	26.48	26.54	0.06	17.76	17.67	0.09
		Average	0.05		Average	0.03

Table 2: Repeatability of the SMART 6 – ORACLE for Moisture/Solids and Fat in Various Dairy Matrices

Sample	Component	Replicates			Average	Range	Std. Dev.
		1	2	3			
Skim Milk	Moisture/Solids	9.27	9.28	9.28	9.28	0.01	0.01
	Fat	0.17	0.19	0.20	0.19	0.03	0.02
Yogurt	Moisture/Solids	20.69	20.73	20.65	20.69	0.08	0.04
	Fat	1.20	1.15	1.15	1.17	0.05	0.03
Low Fat milk	Moisture/Solids	10.94	10.95	10.97	10.95	0.03	0.02
	Fat	2.01	2.00	2.00	2.00	0.01	0.01
Whole Milk	Moisture/Solids	11.86	11.87	11.91	11.88	0.05	0.03
	Fat	3.21	3.19	3.21	3.20	0.02	0.01
Ice Cream	Moisture/Solids	39.16	39.16	39.06	39.13	0.10	0.06
	Fat	13.56	13.46	13.54	13.52	0.10	0.05
Half & Half	Moisture/Solids	18.42	18.48	18.41	18.44	0.07	0.04
	Fat	10.13	10.04	10.08	10.08	0.09	0.05
Processed Cheese	Moisture/Solids	41.47	41.63	41.63	41.58	0.16	0.09
	Fat	30.97	30.99	30.99	30.98	0.02	0.01
Natural Cheese	Moisture/Solids	37.05	37.00	37.15	37.07	0.15	0.08
	Fat	32.72	32.87	32.64	32.74	0.23	0.12
Cream Cheese	Moisture/Solids	65.43	65.42	65.48	65.44	0.06	0.03
	Fat	22.91	22.82	22.82	22.85	0.09	0.05
Cream	Moisture/Solids	46.86	46.90	46.88	46.88	0.04	0.02
	Fat	41.55	41.54	41.53	41.54	0.02	0.01
Sour Cream	Moisture/Solids	26.47	26.45	26.51	26.48	0.06	0.03
	Fat	17.76	17.77	17.75	17.76	0.02	0.01

Conclusion

These results demonstrate the ability of the SMART 6 – ORACLE to reliably determine the moisture/solids and fat content in dairy samples with an accuracy closely matching that of the reference methods. In addition, there are inherent repeatability advantages over wet chemistry reference methods, which are error prone due to a strong dependence on a range of experimental factors (e.g. extraction time, solvent composition, temperature, etc.).

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