Rapidly Analyzing Moisture and Fat Content in Dairy Powders

Introduction

The global milk powder market has been increasing over the past decade and is expected to have a compound annual growth rate of 4.4% through 2025. Milk powders are used to increase the shelf life of milk without using refrigeration. There are various types of dairy powders including, whole milk powder, skimmed milk powder, and various whey-based powders. They are widely consumed globally due to their nutritional benefits, which make them important for infant formulas, nutritional drinks, and other baked products. Due to its nutritional value, it is increasingly important for dairy producers to be able to rapidly analyze the fat content of the milk powders during production to maximize not only time savings, but to ensure that the highest quality product is being made.

The ORACLE™ is a rapid time-domain NMR (TD-NMR) instrument incorporating proprietary technology that allows for direct determination of fat in any food sample. Unlike other rapid techniques, the ORACLE is able to completely isolate the detection of fat in complex matrices, eliminating the need for calibration. To achieve both rapid moisture, solids, and fat testing, the ORACLE can be coupled with a SMART 6™ moisture and solids analyzer. An assortment of eight samples were obtained and analyzed to demonstrate the ability of the SMART 6™ and ORACLE to accurately and reliably determine the fat and moisture content throughout the manufacturing process.

Experimental

Each sample was 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 underwent 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 1–2 grams. Each sample was analyzed in duplicate for the reference analyses (AOAC approved methods) and in triplicate for the SMART 6 and ORACLE analyses.

Note: High-throughput fat analyses can be enabled through the use of batch automation, using an optional robot and high-capacity heater blocks (100 positions each).

Results and Discussion

Repeatability is shown in **Table 1**, where the standard deviations ranged from 0.01–0.27% for moisture and solids, and 0.02–0.14% for fat. The accuracy of the SMART 6 and ORACLE results is demonstrated in **Table 2**, where the average reference results are compared with the average of the SMART 6 and ORACLE results. The average difference ranged from 0.03–0.19% for moisture and solids, and 0.03–0.23% for fat.

Table 1: Repeatability of the SMART 6 and ORACLE for Moisture and Solids and Fat in Various Dairy Powder Samples

		Replicates				
Sample	Component	1	2	3	Avg.	STDEV
WPC 80	Moisture	5.52	5.58	5.65	5.58	0.07
	Fat	5.16	5.23	5.14	5.18	0.05
Skim Milk Powder	Moisture	4.09	4.03	4.07	4.06	0.03
	Fat	0.60	0.60	0.56	0.59	0.02
WPC 34	Moisture	5.88	5.80	5.37	5.68	0.27
	Fat	8.85	8.87	8.79	8.84	0.04
MSC	Moisture	2.00	2.06	2.02	2.03	0.03
	Fat	61.48	61.26	61.22	61.32	0.14
WPH	Moisture	4.48	4.26	4.23	4.32	0.14
	Fat	6.99	6.91	6.80	6.90	0.10
MPI	Moisture	6.97	6.99	6.86	6.94	0.07
	Fat	1.26	1.21	1.27	1.25	0.03
NFDM	Moisture	3.99	4.04	4.07	4.03	0.04
	Fat	0.62	0.57	0.61	0.60	0.03
Infant Formula	Moisture	2.86	2.88	2.87	2.87	0.01
	Fat	28.37	28.37	28.33	28.36	0.02

Table 2: Accuracy of the SMART 6 and ORACLE for Moisture, Solids, and Fat in Various Dairy Powder Samples

	Moisture/Solids			Fat		
Sample	Smart 6	Oven	Diff.	ORACLE	Ref.	Diff.
WPC 80	5.58	5.50	-0.08	5.18	5.15	-0.03
Skim Milk Powder	4.06	4.03	-0.03	0.59	0.47	-0.12
WPC 34	5.68	5.87	0.19	8.84	9.01	0.17
MSC	2.03	2.16	0.13	61.32	61.52	0.20
WPH	4.32	4.35	0.03	6.90	6.82	-0.08
MPI	6.94	6.82	-0.12	1.25	1.31	0.06
NFDM	4.03	4.13	0.10	0.60	0.78	0.18
Infant Formula	2.87	2.84	-0.03	28.36	28.59	0.23

Conclusion

These results demonstrate the ability of the SMART 6 and ORACLE to reliably determine the moisture, solids, and fat content in dairy powder 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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